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Dear Colleagues and Friends,

Welcome to Madison, WI, and to the 52\textsuperscript{nd} annual conference of the International Society for the Systems Sciences.

Regardless of how firm the plans, or how clear the initial vision, a conference is an evolving process. This one even began without a location, since I had no physical university campus or facility from which to host it. Thanks to Tim Allen, our incoming president, we were able to secure space in this beautiful venue on the campus of the University of Wisconsin, in Madison. That was only the beginning of the process, though, because it was through the connection with Tim that I learned much more about his work, and that of his many colleagues and the larger network of researchers focused on the immense complexities of ecological systems and sustainability. Rather than changing the focus of the conference, it only brought more focus and clarity to it.

The theme initially chosen for the conference was Systems That Make a Difference, drawing from Gregory Bateson’s notion of information as “a difference that makes a difference.” The intent, though, was never to make this a conference about Gregory Bateson, or about his work explicitly. It was to borrow from his thoughts as yet another way to challenge our collective work and our direction as a society. In my incoming presidential address last year, I tried to capture the same intent in terms of the (apparent) dichotomy between rigor and relevance. It is critical that our work be sound, and that we not tolerate groundless fantasies as representing us. If our work results in no direct value to the larger society, though, we can hardly blame the general public for not understanding.

We know the implicit value of our work. For over 50 years we have been led and joined by dedicated, intriguing, and often brilliant thinkers. Sometimes others have understood the importance of systems sciences; often they have not. Many of those who have glimpsed its importance have done so at a distance, and opaquely. Universities rarely knew where to situate programs. Funding agencies typically preferred simpler, narrower approaches that promised unequivocal answers or predictions, regardless of their limitations.

Some have declared the systems sciences to be vestiges of the past; something which had its time, but whose value is gone. On the contrary, it may be another 50 years, or more, before these ideas are truly understood enough to move into the mainstream.

In the meantime, the list of challenges that we are facing is growing rapidly. This has been another devastating year of natural disasters for people in many places around the world. More importantly, both policy-makers and the general public seem to be starting to understand the interconnectedness of energy, economics, food supplies, the environment, etc. Unfortunately, that
only causes many to throw up their hands in helplessness. It may be a time, though, when we can begin to think in new ways.

We have, as society, made a difference simply by carrying forward the ideas of our founders. I can’t imagine that they would be content to stay where we are, though. We have much more that we can do.

I welcome each of you to this conference, with all of the ideas and energy that you care to bring to it. I think that you will find room for all that you are willing to share and contribute.

Gary S. Metcalf
2008 President, International Society for the Systems Sciences
DISTINCTIONS, SYSTEMS, RELATIONSHIPS, PERSPECTIVES: THE SIMPLE RULES OF COMPLEX CONCEPTUAL SYSTEMS

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ABSTRACT

The creation, acquisition, and development of concepts is broadly relevant to the arts and sciences and is essential to thinking, learning, education, psychology, cognitive science, creativity, and interdisciplinarity. Cognitive scientists and philosophers have proposed several concept theories, each with their advantages and disadvantages. This paper proposes an alternative view of concepts as complex conceptual systems governed by a simple set of rules that are formalized by the DSRP theory of concepts (an acronym of four simple rules: Distinctions, Systems, Relations, and Perspectives). Because DSRP is speculative, justification should be sought in: (1) future research, (2) correspondence with knowledge and experience, and (3) heuristic value in comparing and synthesizing existing theories. Individually, the components of DSRP have long been the subject of theoretical and empirical studies. However, it is the dynamic behavior and fractal self-similarity of these four rules acting together which provides a novel contribution to knowledge of concepts

‘If symbols are the atoms of the mind, then every thought is one of Schrödinger’s cats.’

INTRODUCTION

Concept theorists in the cognitive sciences and philosophy have proposed several theories of concepts including: classical, prototype, theory-theory, neo-classical, and conceptual atomism (Laurence and Margolis 1999). Each of these competing theories is weakened in some way or another by problems such as: compositionality, reference determination, categorization, and stability. The reader is directed to Laurence and Margolis (1999) who provide a thorough review in their edited volume covering such theories and problems in greater depth.

This paper proposes an alternative concept theory called ‘DSRP’, the acronym formed by its four component rules or patterns: Distinctions, Systems, Relationships and Perspectives. DSRP provides the mechanism for a view of concepts as dynamic, patterned, evolving, adaptive and complex. From this complex view, even a single concept can be thought of as a robust complex system. Complex adaptive systems (CAS) are systems in which the individual behavior of agents following simple local rules leads to complex and emergent properties. Nobel laureate Murray Gell-Mann (1995/96) describes the relationship between simple rules and complexity:

It is important, in my opinion, for the name to connect with both simplicity and complexity. What is most exciting about our work is that it illuminates the chain of connections between, on the one hand, the simple underlying laws that govern the behavior of all matter in the universe and, on the other hand, the complex fabric that we see around us, exhibiting diversity, individuality, and evolution. The interplay between simplicity and complexity is the heart of our subject.
It is interesting to note, therefore, that the two words are related. The Indo-European root *plek- gives rise to the Latin verb plicare, to fold, which yields simplex, literally once folded, from which our English word “simple” derives. But *plek- likewise gives the Latin past participle plexus, braided or entwined, from which is derived complexus, literally braided together, responsible for the English word “complex.” The Greek equivalent to plexus is plektoV (plektos), yielding the mathematical term “symplectic,” which also has the literal meaning braided together, but comes to English from Greek rather than Latin.

Complex Adaptive Conceptual Systems (CACS) is a term invented to describe this new approach to concepts. CACS explore the pattern of relations between concepts and their environment. In complex ecological systems, an ecosystem is made up of the many abiotic factors and biotic organisms within a given area. Abiotic factors include the solar, climactic and geological factors, while biotic features include a host of varied organisms. Complex concept ecologies are made up of content and context. Content is defined as the set of symbolic or informational variables in a conceptual space. Alfred Korzybski (1933), who developed the theory of general semantics, explained that the ‘map is not the territory’. A concept is not merely its content (i.e., symbol-labels such as ‘dog’ or ‘terrorist’ or the image-symbol ‘🐕’) but is a function of the context it is in. Any given concept is a function of its interrelationships and organization with other concepts in the conceptual space.

Context is a set of processing rules for content; the resulting pattern of interaction yields concepts. This treatment is similar to Guilford’s original framework for divergent thinking. Kaufman (2006) explains that Guilford’s divergent thinking was an ‘attempt to organize all of human cognition along three dimensions’. Guilford’s three dimensions include thought processes, content, and the products of the interactions between process and content. A whole mess of these conceptual patterns is referred to as a ‘CACS’—a pattern of content (symbolic variables) and context (processing rules). As a formal set of processing rules, DSRP offers a mechanism for the pattern of interaction among content and context that results in concepts. Each of the four rules contains an interaction between two elements as shown in Table 1 below.

Table 1: Concepts are a pattern of relations between content and context. DSRP is the rule-set for context

<table>
<thead>
<tr>
<th>Concepts</th>
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<table>
<thead>
<tr>
<th>Content</th>
<th>Context</th>
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<td>(∀ informational or symbolic variables)</td>
<td>(processing rules/patterns)</td>
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(D)(S)(R)(P)⇒{DSRP}

- Distinction (D) ⇔ {identity (i) ⇔ other (o)}
- Relationship (S) ⇔ {part (p) ⇔ whole (w)}
- System (R) ⇔ {affect (a) ⇔ effect (e)}
- Perspective (P) ⇔ {subject (s) ⇔ object (o)}

AXIOMS OF A COMPLEX SYSTEMS APPROACH

Before providing a formalism of DSRP, four axioms that situate DSRP in a complex systems approach to the study of concepts are proposed. The following axioms situate DSRP within a complex, dynamical, evolving, ecological, adaptive, systems framework.

Axiom #1: A concept’s environment is conceptual. A concept exists within a specified environment made entirely of other concepts. That is, a concept’s ecology includes only other concepts and the patterns of interconnection between them, which are themselves concepts. Therefore, a conceptual ecology is unlike other types of ecologies because every instantiation is a concept. Whereas other types of ecologies contain many different kinds of things, concept ecologies only contain concepts that are the interaction patterns of content (A, B, C, dog, cat, +, ÷) and its contextual organization.

Axiom #2: A human is a biological bag of concepts. Because every concept is in fact a fuzzy set of concepts, a conceptual system rather than discrete object, the study of complex conceptual systems need not differentiate among a single concept, a collection of concepts, an individual
person, or a group of individuals. That is, because all concepts are conceptual systems there is no significant difference between one conceptual system and the sum of all conceptual systems for an individual or group. An individual or group of individuals is merely a large conceptual ecology encased in biological or social-biological wrappers. Humans are all merely biological bags of ideas. The implications of this alternative and abstract view of human identity are that all human and group identity is derivative of the aggregation of conceptual systems for the individual or group. In other words, humankind is what it thinks either alone or in groups and sub-groups. This suggestion has rather large implications for the conceptual ecologist, and it is justified by a simple explanatory example. In general, human beings are not irreparably divided by biology or geography, but instead by their conceptual systems. That is to say that, in general, all humans are biologically compatible. This is reminiscent of lyrics by the musical artist, Sting, in his song called ‘Russians,’ written toward the end of the Cold War: ‘We share the same biology, regardless of ideology, what might save us, me, and you, is that the Russians love their children too’ (Sting 1985). There is nothing about the biological, geographical or social existence that makes humans inherently and irreconcilably incompatible. What causes humans to be incompatible are their conceptual systems in the form of beliefs, ideologies, ideas, and assumptions. Therefore, from the perspective of a conceptual ecologist, the compatibility or incompatibility of a given individual or group of individuals is based on the respective conceptual ecologies of those individuals. In addition, human identity as individuals or groups is derivative of shared conceptual ecologies. Therefore, understanding the discrete mechanisms that drive the formation and development of concept ecologies and the complex ways that conflicting concept ecologies can cohere is a cornerstone of psychosocial compatibility and communication (e.g., peace, cooperation, etc.).

Axiom #3: Conceptual systems can be any size. Conceptual ecologies can be any size. As will be demonstrated, even a single concept is an ecology. The words of Samuel Butler are appropriate, ‘A definition is the enclosing a wilderness of idea within a wall of words’ (Butler 2004). A single concept, the sum of all concepts held at any time by an individual, or the sum of concepts held by a group of individuals can all be conceptual ecologies. Concept ecology is an abstract term that can be used to describe a conceptual system at any scale. It should be noted that while, hypothetically, a concept ecology can be infinite, our individual processing capacity makes these conceptual spaces limited and finite.

Axiom #4: Everything is a concept. To a ‘conceptual ecologist’, everything is a concept. Whether the actual phenomenon under investigation is physical, chemical, biological, psychological, social, theological, epistemological, ontological, philosophical or even whether it is true or untrue, it is viewed from a conceptual orientation. To a conceptual ecologist the object under investigation is always the concepts being had about an object rather than the object itself. Initially, this may seem like a strange notion, yet it is one that plays out every day in the various disciplines: a physicist views any system as the result of physical laws of interaction; a chemist imagines the molecular dynamics of plastics and people alike; a biologist sees organisms, the results of organisms, evolutionary processes and ecological systems wherever she looks; the economist is famous for mounting any system into an economic frame; the business man sees product innovations in the works of the engineer while the engineer sees a business as a dynamical system of control processes, circuitry, and feedback. The concept ecologist is no different; their study of any given phenomenon is an investigation of a conceptual system. Even invalid concepts are concepts, so they are covered by this axiom. Conceptions and misconceptions follow the same processing rules so it makes little difference whether a concept reflects reality or truth. Concept ecology investigates conceptual systems that are devoid of fact with the same veracity that it investigates conceptual systems that are factual. Of course, the
analysis itself does need to correspond with reality. For example, when analyzing a child’s misconception of causality, the investigation should describe or predict present or future errors in structure or pattern.

DSRP

What follows is a concise explanation of DSRP\textsuperscript{ii} based on four rules of conceptualization: Distinction, System, Relationship, and Perspective. It is shown that the existence and nature of concepts necessitates these dynamical rules, and that these rules are also sufficient to describe the conceptual dynamics. This exposition is organized into three sections: (1) formalism of DSRP, (2) the formal DSRP Diagrams, (3) classical logic as an example of a limited conceptual system expressing DSRP, and (4) dynamics of DSRP and implications.

It should be noted that theoretical, empirical and practical examples exist for each of the individual patterns of D, S, R, and P and that this work is often transdisciplinary (occurring across different fields). An inventory of such works relating to each pattern has been amassed by the author some of which include: for Distinction Rule (Clark 1994; Cook and Campbell 1979; Coye 1986; Davies 1982; Dorfman 1967; Durand and Calori 2006; Edwards 2004; François 2004; Gillette 1925; Glanville 1990; Grossberg 1997; Hardin 1968; Herbst 1995; Heylighen 1989; Langer et al. 1985; Leudar et al. 2004; McWhorler 2001; Newman and Jusczyk 1996; Perdue et al. 1990; Rubin 1921; Spencer Brown 1969; Tajfel and Wilkes 1963); for System Rule (Ackoff 1971; Anderson 1991; Bertalanffy 1972; Cabrera 2006; Davidz et al. 2004; Lewin et al. 1935; Midgley 2000; A. Tversky and Kahneman 1981; B. Tversky and Hemenway 1984; Wertheimer 1923); for Relationship Rule (Cook and Campbell 1979; Gopnik et al. 2004; Grotzer 2005; Pearl 2000; Piaget 1974; Schulz and Gopnik 2004); and for Perspective Rule (Batson et al. 1997; Davis et al. 1996; Davis et al. 2004; Duncker 1929; Galinsky and Moskowitz 2000; Marvin et al. 1976; Neale and Bazerman 1983; Parker and Axtell 2001; Piaget 1974; Premack and Woodruff 1978; Schober 1993; Whitehead 1967). These are provided here as references but future work should include evaluative and integrative reviews of this literature.

DSRP Formalism

In cognitive systems such as the human mind, ideas are constantly evolving. Concepts are not static; they simultaneously adapt in response to other concepts, link together with them, conflict with them or coexist. How might this occur? As is often the case, the essence of the objects in question (concepts) determines the rules by which they behave. Consider a simple conceptual system consisting of a concept A.

Concepts exist only in context with other concepts. For instance, my concept of DOG exists in the context of ANIMAL and FURRY and THING, etc. In general, any concept A has identity only in contrast to some other concept from which it can be distinguished (for instance, there must at least be a concept of ‘not A’ or ‘other than A’). In order to make a distinction, one must establish an identity and exclude the ‘other.’ Distinction making is a universal pattern of evolutionary epistemology and of conceptual ecologies. All distinction making involves a boundary that differentiates between what/who is in and what is out, between internalities and externalities. Recognizing the universality of Distinction making involves recognition of the importance of giving things names and in doing so, creating boundaries and highlighting or valuing certain patterns over others. So A necessitates the existence of some other concept, which will be called B. Consequently, A also necessitates the distinction between A and B. The interrelation of concepts may also be thought of in terms of a general notion of affect and effect. For instance in the case of distinctions, A affects B to be distinct from A and B affects A to be distinct from B,
etc. Thus a distinction is comprised of the two concepts in question and four relations or two interrelations: the affect of identity from A, the effect of identity on B, the affect of identity from B and the effect of identity on A, each of which is shown in Figure 1.

![Figure 1. The related elements of a distinction: identity (i) and other (o)](image1.png)

This does not imply that A affects B or vice versa but that A affects an A-like-effect on B and vice versa. Think of this interaction as the effect your boss might have on you in a meeting. Your boss (or wife, siblings, colleagues) does not cause your identity, but can shape it in a particular context. Our identity and behavior is often a function of the people and context in which we are situated (Davis-Blake and Pfeffer 1989; Granovetter 1985; Kluger 2006; Ridgeway and Correll 2004; Smith-Lovin and McPherson 1992; Tsui and Oreilly, 1989); the same is true for concepts. If there is a distinction between A and B, there must be some concept of relationship between them, namely at least that relation of being distinct. The relation of being distinct in Figure 1 is dependent on the more general relationship rule. As shown in Figure 2, generally, relations are comprised of two relations and four interrelations: the affect of relation from A to B and from B to A and the effect of relation on B from A and on A from B. Making relationships between otherwise different concepts increases connectivity and expands the within-group distinction; realizing the degree to which we are interconnected makes the lines between in/out group increasingly fuzzy and eventually redrawn; relationship making forces our conceptual systems to expand and become more interconnected and more fuzzy but over time as these relationships mutually reinforce each other, concepts can also crystallize or become more concrete.

![Figure 2. The related elements of a relationship: affect (a) and effect (e)](image2.png)

Any collection of related concepts can naturally be viewed as a system. So A necessitates the system in Figure 3 which can be expressed as the collection of concepts and the four interrelations between them: the affect of membership from A, the effect of membership on B, the affect of membership from B and the effect of membership on A as well as the part-part interactions of which relationships are considered parts. Here, membership can be entire or partial, in the sense that A may be contained in B, B may be contained in A, A and B may be
effectively disjoint, or sub-concepts of A may be contained in B and vice-versa (partial membership). Of course, at any given time A contains A (but almost certainly not at different times. This will be discussed more in the dynamics section).

![Figure 3](image3.png)

**Figure 3.** The related elements of a system: part (p) and whole (w) (*part-whole relations not shown)*

Furthermore, any concept naturally carries with it a perspective or frame of reference, for instance A from the perspective of B, or vice versa, in Figure 4. This conceptual perspective-taking is akin to viewing one concept from the point of view of another and therefore necessitates a subjective viewer (subject) and an objective view (object)—a subject-object relationship. Conceptual ecologies are made up of interacting concepts. Each concept has a unique identity but can also take a point of view on its environment. This point of view is attributional. That is, from the human concept bag perspective, the concept bag takes an attributional view of one of the smaller concepts in its bag and views another concept from that point. Therefore, reorienting a system of concepts by deciding the focal point from which attribution occurs is a central function of all conceptual systems. By attributing a conceptual state to a conceptual point in the system, a view of the other objects in the system can be established (e.g., a point of view). This ‘perspective taking’ or ‘conceptual attribution’ can have a catalytic effect on the conceptual system as a whole, causing a cascade of interconnections and reorientations. Perspective has the potential to instantly transform whole systems, rearrange distinctions, and cause relationships to disappear. Perspective can similarly be characterized by the relevant concepts and the four causal interrelations: the affect of subject or observer from A, the effect of object or observed on B, etc.

![Figure 4](image4.png)

**Figure 4.** The elements of a perspective: subject (s) and object (ô)

This can be most easily demonstrated by bringing a third concept C into the mix, as shown in Figure 5. The BC system can be viewed from A’s perspective as A(BC), or alternatively AC can be viewed from B as B(AC), etc. This conceptual perspective taking—attributing a perspective to a concept rather than an individual—is an essential aspect of human thought processes, creativity, innovation and problem solving. It is the conceptual equivalent to attribution of mind theories.

Also, perspectives may be regarded as distinctions between the viewer and the viewed, or as systems of viewpoint (reference frames). One might take the perspective of an individual who is a large concept ecology or of a group of individuals or of a single concept. Of course, when one takes another’s perspective, one is not actually seeing the other’s perspective but instead is taking a conceptual attribution of one’s concept of the other.

The argument here is that the nature of concepts necessitates the existence of distinctions, relationships, system-making and perspective-taking. Each of these four rules is a special kind of relation between two elements: identity-other for distinctions, affect-effect for relationships, part-whole for systems, and subject-object for perspectives.

![Figure 5. A’s perspective on the system (BC) and B’s perspective on the system (AC), respectively](image)

Furthermore each of these rules and elements is itself a concept, to which the DSRP rules apply. For instance, a relation R may be viewed as a concept, which is distinguished from another concept (such as A and B, or some other relation R’). A relation may also be viewed as a system or part of many systems, or one can view a conceptual system from the perspective of R. The same analysis can be applied to a system: a system can be thought of as, for instance, a relation between other systems as in Figure 6 (for instance the system of ‘superstitious thought’ might be regarded as a relation between the systems of ‘eastern mysticism’ and ‘monotheistic religions’).

All of the rules of DSRP are interdependent and simultaneously implemented by each concept. At a micro-level it is important to note that an instantiation of: D requires instantiations of SRP; S requires instantiations of DRP; R requires instantiations of DSP; and P requires instantiations of DSR. So it can be said that each rule is dependent upon the other rules, that: D is dependent on SRP; S is dependent on DRP; R is dependent on DSP; and P is dependent on DSR. These micro-interactions occur on every concept at every step in time. At a macro-scale, DSRP operates on complexes of content (A, B, AB, etc.). Concepts (content and context) exist in a space of concepts and interact with each other. Each concept is comprised of a system of sub-concepts, all of which are implementing DSRP rules. Concepts interact with each other via the DSRP rules, i.e. forming distinctions, relations, etc., as their sub-concepts interact. The sub-concepts also have sub-concepts, which overlap with other sub-concepts, all of which are simultaneously implementing DSRP. At each step and at each point in the concept ecology, DSRP operates simultaneously. The number of such associations (sub-concepts and DSRP implementations) is so large that it can be taken to be effectively infinite, yielding an essentially scale-free DSRP network (meaning that DSRP is a sort of fractal algorithm). That such a rule system is sufficient to lead to interesting conceptual dynamics will be illustrated further in the dynamics section.

DSRP Diagrams

The above illustrations are intended to convey the mechanics of DSRP to the reader but these illustrations do not illustrate the interdependence and parallel processing that is essential to DSRP’s dynamics. For the purpose of precise conceptual modeling, more formal DSRP diagrams are necessary. The following is a brief introduction to the most basic DSRP Diagrams. The rule set for the diagrams states that: (1) each rule implies the set of rules, (2) each rule implies its elements and vice versa, and (3) each element implies its co-element. All processing that occurs in the diagrams is derived from the DSRP rule set:

\[(D)(S)(R)(P) \propto \{\text{DSRP}\}\]

Distinction (D) $\Leftrightarrow$, \{identity (i) $\Leftrightarrow$, other (o)\}
Relationship (S) $\Leftrightarrow$, \{part (p) $\Leftrightarrow$, whole (w)\}
System (R) $\Leftrightarrow$, \{affect (a) $\Leftrightarrow$, effect (e)\}
Perspective (P) $\Leftrightarrow$, \{subject (s) $\Leftrightarrow$, object (ô)\}

The advantage of DSRP Diagrams is that they include the various interdependencies of DSRP rules. In Figure 6 the basic structure of each of the DSRP rules is illustrated in (a). Each rule has two elements and in (b) these elements are inserted into multi-rule line between A and B. The elements of each rule are: identity (i) and other (o) for distinction, part (p) and whole (w) for system, affect (a) and effect (e) for relationship and subject (s) and object (ô) for perspective. The multi-rule line in (b) illustrates that all of these relational elements are occurring simultaneously between A and B.
Figure 7. (a) The basic structure of DSRP rules, (b) A multi-rule line between A and B

The elements of the multi-rule line can be ‘active’ (1), ‘inactive’ (0) or ‘passive’ (*). Passive means that the rule is operating in the background but is not being explicitly considered. Setting rules to passive is usually done to decrease the complexity of an explanation by looking at a discrete operation at a discrete moment in time and holding other rules constant in order to isolate the effect of the rule being considered. In reality, all of the rules would be parallel processing and could be on active, inactive or passive to greater or lesser degrees. In each of the diagrams below, for the purpose of explanation, we will isolate one rule and set the others to passive (*). Figure 8 shows the various possible configurations of the rules on the multi-rule line: all active in (b), all inactive in (c), all passive in (d) and a mixture of active, inactive, and passive in (e).

Figure 8. Rule settings of the multi-rule line

Figure 9 illustrates the macro-structure of DSRP Diagrams. Concepts and/or content are input. Time flows from left to right, but the processing area occurs simultaneously in a single unit of time. Outputs come in the form of concepts (content and context).
Figure 9. Macro structure of DSRP diagrams

Figure 10 illustrates how the multi-rule line notation works by indicating the differences between three different cases of a distinction. A and B are the content input for each of the diagrams but note that the conceptual output differs in each case: A, B and ¬A, respectively. These differences are determined by the status of the rules on the multi-rule line. In (1), the D columns for A and B are set to i=active and o=inactive for A and i=inactive and o=active for B. This is based on the distinction-rule: \( D \Leftrightarrow (i \Leftrightarrow o) \). The SRP columns for A and B are set to passive because we are isolating the D-rule. Note that the output in (1) requires a correlation of identity and other for A and B and therefore A and B can be thought of as a system. The perspective is operating on D-rule itself, which can be expressed, ‘from the perspective of distinction-rule, the interaction of A and B with the following configuration of context yields the concept A’. So it can be shown that while SRP are indicated as passive, they are operational in the background for any D.
In (2) the opposite configuration of context is illustrated which yields the output B. Everything stated above for the example in (1) holds true for this contrasted example in (2). In (3), two rules are active (distinction and perspective) such that one gets the output ¬A or, ‘from the perspective of A, B is not-A’. Replacing us for A and them for B we get, ‘from the perspective of us, them is not-us’. Or alternatively, by replacing them for A and us for B we get, ‘from the perspective of them, us is not-them’. Using the outputs of Figure 10 as inputs to an S-rule one could generate the system (A, ¬A, B, ¬B) and then use D-rule again to distinguish between that system and other systems such as S(A, ¬A) and S(B, ¬B) which would be akin to differentiating between conceptualizing the old woman, the young woman or both in Figure 11.
The number of combinations and iterations that can be generated from these simple rules is effectively infinite. Now we will review each rule in isolation bearing in mind the description above of how the multi-rule line works. The diagram in Figure 12 shows the formalism for a distinction, accepting the content A and B and processing the distinction A. In this case, B is contained in the distinction A functioning as not-A or other.

Figure 13 illustrates the formalism for a uni-directional causal relationship between A and B, for mutual correlation or causality between A and B, and for feedback in a two-step diagram. Note that the diagram of feedback is more accurate and robust than standard feedback diagrams, which have the tendency to confuse by abstracting time. Traditional feedback diagrams unintentionally convey that the A that is the initial cause is the exact same A that is the recipient of the feedback, when in fact time differentiates these As as A and A’. If the ‘feedback’ is occurring simultaneously, then the notion of ‘back[ward]’ is a misnomer and what is more accurately being referred to is mutual causality or correlation as shown in part b of Figure 13.
Figure 13. Three R diagrams: directional, mutual, and feedback causality

Figure 14 shows a S-rule diagram in which outputs—two distinctions (A and B) and a relationship (R_{AB})—are taken as inputs. The diagram shows the birth of a system that includes both part-to-part correlations and part-to-whole correlations. The co-relationships between each part and the whole (membership) is indicated by the three multi-rule lines connecting A, B, and R_{AB} to the whole (A, B, R_{AB}) inside the frame on the right. Inside the frame, the whole is composed of three part-to-part interactions between: A and B, A and R_{AB}, and B and R_{AB}. The resulting output is the system S(A R_{AB} B).

Finally, Figure 15 shows a perspective diagram in which the interaction of identities A and B are organized by the subject-object rule to output the perspective A(B). Note the difference between the output for Figure 15 and that of Figure 10, item (3) above. In (3), the D and P rules are in use yielding the concept ¬A whereas in Figure 15 the same P-rule configuration yields A(B). This is because the observer and the observation is not the same.

DSRP diagrams can be powerful tools whenever a concise conceptual formalism is required, although much simpler drawings also suffice for various applications. The DSRP Diagrams do provide a more accurate picture of the complexity of DSRP, its fractal structure, and the effectively infinite diversity of output.

Logic: A Limiting Case

It is interesting to note how DSRP rules are built into, both manifestly or implicitly, earlier conceptual models such as semantic networks and symbolic logic. For example consider symbolic logic. In classical logic, concepts are represented by variables like {A, B, C, =, ¬, α, {, (, [ } etc., which are taken to be static objects. These variables form what is called the model’s lexicon. All variables are considered objects, but objects like = and α are further defined as relations. These relations distinguish between objects like A and B, and form relationships between them.
Furthermore, collections like \{A, B, C, \alpha\} can be grouped into systems using objects like ( ‘or ’\{, for instance as written below:

\{A, B, C, ) , ( , ) \}

Or as a relational system, for instance:

A \alpha (B \alpha C)

Perspective is implicit in the formulation of classical logic since statements like

A \alpha (B \alpha C) and (A \alpha B) \alpha C

are a priori taken to be distinct systems, i.e. statements can be made from the perspective of A or B or C or (A \alpha B), etc. Any equivalence of such statements must be proven. Causal interrelations are also implicit in symbolic logic. Consider the statement A\alpha B. Here ‘\alpha’ is the relation of implication from A to B, which can be thought of in terms of the effect of implication from A, the effect of implication on B, the effect of implication from B, and the effect of implication on A. Similarly, A is distinct from B due to the affect of identity from A and the effect of identity on B, etc. These causal relations are not explicitly stated in the axioms of symbolic logic, but are inherent to the structure of its statements.

The rules of distinction, relation, system and perspective are necessary for the construction of classical logic. However, classical logic describes static and atomistic objects with precisely-defined relations. These extra assumptions reduce its robustness. Also, a great deal of what has been explained above—especially where the elements of DSRP are concerned—is implicit in logic. Logic therefore fails to model the composite and dynamic nature of concepts by neglecting to implement DSRP rules at every level of conceptualization. Table 2 contrasts logic and DSRP.

<table>
<thead>
<tr>
<th>Symbolic Logic</th>
<th>DSRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>static, atomistic</td>
<td>dynamic, emergent,</td>
</tr>
<tr>
<td></td>
<td>adaptive, redundant</td>
</tr>
<tr>
<td>limited case, finite;</td>
<td>Scale-free, fractal</td>
</tr>
<tr>
<td>‘smoothly connected’</td>
<td></td>
</tr>
<tr>
<td>implicit dynamics</td>
<td>explicit dynamics</td>
</tr>
<tr>
<td>more tractable</td>
<td>less tractable</td>
</tr>
<tr>
<td>less robust representation</td>
<td>more robust representation</td>
</tr>
<tr>
<td>of conceptual systems</td>
<td>of conceptual systems</td>
</tr>
</tbody>
</table>

Table 2: Contrasting Symbolic Logic and DSRP
**Dynamics**

In human conceptual systems, concepts are fuzzy. They are made up of many associations: many other overlapping concepts, all of which are interacting in terms of distinctions, relations, systems, and perspectives simultaneously. For example, my notion of DOG consists of many other concepts such as FUZZY and FRIEND and (because I’ve actually eaten dog in a roadside eatery in Viet Nam) VIETNAMESE FOOD, each of which overlap with other concepts such as BUNNY and another Vietnamese culinary favorite PHO, respectively.

From this recursive application of DSRP one gets a picture of concepts as fuzzy sets, each (partially or wholly) containing other fuzzy ideas, which overlap with other fuzzy ideas in a large fuzzy network. These DSRP interactions between concepts and sub-concepts at all levels of conception lead to time evolution of concepts in the form of warping of the fuzzy set and changing degrees of overlap with other fuzzy sets (making fuzzy connections in the fuzzy conceptual network). In order to put a concrete model to this dynamical picture, we can reinterpret the fuzzy idea as a probability distribution or a conceptual orbital or wavefunction. Specifically, given a concept (fuzzy set) A as above, we can reasonably model its fuzziness as a conceptual nucleus of core sub-concepts surrounded by a wavefunction quantifying its fuzziness, similar to the atomic model of quantum mechanics (Figure 16).

![Figure 16. Wavefunction $\Psi$ of concept A](image)

Continuous implementation of DSRP by sub-concepts of A average to form this wavefunction $\Psi A$, which quantifies the fuzziness of the concept A in a similar manner as the wavefunction of quantum mechanics quantifies the fuzziness of the atom. The interaction of two ideas A and B, which is comprised of the sub-concepts of A and B implementing DSRP rules, can thus be quantified by the overlap of $\Psi A$ and $\Psi B$, or $\Psi AB$ (Figure 17).
As in quantum mechanics, we can think of $\Psi_{AB}$ as a sort of measure of the probability of A relating to B in the conceptual network. Thus, in DSRP, concepts follow a sort of ‘conceptual chemistry’ in which conceptual interaction via iterated DSRP is modeled by a conceptual bond, quantified by the conceptual orbital. Concepts in the conceptual network can then cluster as atoms do, to form complex conceptual molecules that can flex and move and modify themselves, as in molecular chemical dynamics. These conceptual molecules can be said to form the basis for large systems of interrelated ideas, such as complex theories like DSRP or religions like ‘Pastafarianism’ (Henderson 2006) (Figure 18).
constraints. When a mind is young, few conceptual bonds have been made and there is still much conceptual space in which to work. As the mind evolves in time, more connections are made in the conceptual network. More concepts bond to other concepts in response to data, and conceptual molecules become more firmly established. As the mind approaches its limit of conceptual space, the conceptual network is forced into more regular patterns in order to fit within conceptual space. Conceptual molecules are better established due to more association, and are organized into more regular structures. That is to say, the human mind goes through a sort of conceptual crystallization throughout its development, until eventually the concept bag dies and the mind presumably ceases to function and returns to a state of disorder.

Given our ensemble of concepts and its conceptual chemistry, we can thus define a notion of ‘conceptual entropy’ and subsequently ‘conceptual temperature’. We could then say from the above analysis that a young mind occupies a state of relatively high entropy and temperature, and goes through a process of cooling and ordering until death. If all iterations of DSRP solidify the various bonds then entropy and temperature decrease and concepts become more crystallized or concretized. Over time, and through repeated evaluation and selection, conceptions become more defined leading to phenomena such as belief perseverance. Alternatively, if DSRP rules are used, for example, as an explicit processing heuristic, randomly searching conceptual spaces for bonds across fractal scale, then entropy and temperature increase such as in brainstorming, free-association or creativity. This means that cognitive capacity such as creativity can be increased using a blind variation strategy by using DSRP as processor.

Let us take the entropic analysis one step further to consider larger conceptual space residing in more than one ‘concept bag’ (a.k.a., a human). That is, let us consider the conceptual dynamics within systems of interacting people. For simplicity, let’s consider two concept bags: call them Linda and Larry. Linda is a concept bag with a conceptual system going through a process of evolution. Linda is an open system, because she can receive information from outside her concept bag, perhaps by talking to Larry. Thus Linda is a local fluctuation in conceptual entropy within the larger conceptual network: she goes through life ordering her conceptual system. Thus, in keeping with the view of life as local ordering (decrease of entropy) in response to energy stresses in open systems, concepts can be viewed as behaving like biological organisms. Since Linda can talk to Larry, she can influence the structure of his conceptual network (causing new associations to be formed). If Linda then dies, her individual conceptual system returns to a state of disorder, but the concepts she communicated to Larry live on as structure in his network. This process occurs across billions of concept bags all the time; it is the basis of human interaction and the conveyance of information.

In this sense, concepts move through a conceptual ecosystem, interacting and ultimately competing for survival. They constantly evolve in response to their conceptual environment, obeying rules of conceptual Darwinism that are simply an emergent property of the underlying DSRP algorithm, as Darwinian selection in biology is an emergent property of genetic robustness. Thus DSRP necessarily imparts memetic behavior to concepts and is therefore a mechanism for evolutionary epistemology that describes the micro and macro processes of blind variation and selective retention (Campbell 1960, 1974). Table 3 summarizes the similarities of note between quantum mechanical rules and subsequent chemical, biochemical, evolutionary, ecological, psychological, sociological and cosmological dynamics and DSRP rules in relation to their conceptual dynamics.95
<table>
<thead>
<tr>
<th>Magnification Material Universe</th>
<th>Conceptual Universe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantum Mechanics</td>
<td></td>
</tr>
<tr>
<td>Atoms</td>
<td>Concepts</td>
</tr>
<tr>
<td>fuzzy: by quantified wavefunction $\Psi$</td>
<td>very quantified wavefunction $\Psi$</td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
</tr>
<tr>
<td>$\Psi$ approximated by orbital picture; Overlap quantifies interaction strength; ‘Stable’ configurations: molecules &amp; arrays</td>
<td>$\Psi$ approximated by conceptual orbital picture; Overlap quantifies strength of conceptual configurations: conceptual molecules &amp; arrays (categories, belief structures, etc.)</td>
</tr>
<tr>
<td>Biology</td>
<td></td>
</tr>
<tr>
<td>Robust molecular systems replicate in response to environmental energy demands; Constitute organisms</td>
<td>Robust conceptual systems replicate in response to conceptual environmental demands; (theory, religion, etc.)</td>
</tr>
<tr>
<td>Evolution</td>
<td></td>
</tr>
<tr>
<td>Molecular systems adapt in response to interaction with other organisms &amp; resources; best-adapted survive</td>
<td>Conceptual systems adapt in response to interaction with other conceptual systems, best-adapted survive (i.e., BVSER)</td>
</tr>
<tr>
<td>Ecology</td>
<td></td>
</tr>
<tr>
<td>Contained systems of evolving organisms</td>
<td>Contained systems of evolving conceptual systems</td>
</tr>
<tr>
<td>Psychology</td>
<td></td>
</tr>
<tr>
<td>Material systems have systemic material identities, embody and systematize material traits</td>
<td>Concept bags form systemic personal identities, embody and systematize personal traits (i.e., ‘embodied mind’)</td>
</tr>
</tbody>
</table>

Table 3: Dynamic Similarities between Material and Conceptual Worlds
The dynamics of DSRP make it remarkably similar in structure to quantum mechanics and chemistry, and even to cosmology. DSRP also provides a mechanism for the memetic behavior that must exist in order for evolutionary epistemology to be a viable proposal. For these reasons, DSRP should be considered a more robust alternative to logic where complex cognitive systems are concerned.

**ECOSPHERE: AN EXAMPLE OF DSRP IN PRACTICE**

The formalism and diagrams above are abstract, so it is sometimes helpful to explain how the model works using a real example of conceptualization. The abstraction and diagrams offer the kind of precision that is needed to better understand complex conceptual systems, but a practical description, while crude and imprecise, may offer insight into the utility of DSRP. In the following example of DSRP applied to ‘everyday’ thinking, italics are used to indicate to the reader the sometimes-subtle references to the DSRP rule forms. Drs. Joe Hanson and Clair Folsome first developed the ‘ecosphere’—a self-contained miniature biological world—and NASA became interested in these closed self-sustaining systems under their Mission to Discover Planet Earth program (Abundant Earth 1997-2007; Sagan 1986).

Today, small ecospheres are sold for $100 to $500 for educational purposes or as home decor. Commercial ecospheres, such as those sold by Ecosphere, Inc., include a number of inter-related parts. A glass blown bulb provides enclosure for the system. So, the system itself is a distinction that has an identity (ecosphere) and interacts with things other than it. Even though we call an ecosphere a closed system, the distinction relies on three external phenomena. First, it must receive sunlight (energy). Second, it must be kept at a reasonable temperature for sustaining the life balance within it. Third, it must have a reasonably stable environment (e.g., a stationary table or a shelf). That is, an ecosphere perpetually mounted on the hindquarters of a racehorse will not sustain itself.

Inside the ecosphere the parts include brine shrimp, a branch-like twig, gravel, snail shells, algae, and water. Each of these things is a distinction but is also a part in the larger whole. Of course, each of these things is a whole too, made up of smaller parts that are not all visible to the naked eye. For example, the brine shrimp is made up of parts: tail, head, eyes and internal organs. Each of these is a distinction and each of these is a whole conceptual system—a system of many inter-related parts.

The ecological system that is called an ecosphere has ecological analogs in the tiny intestine of the brine shrimp, for example. Each of these systems is built upon interrelationships between parts of the whole. The system itself, including all of these parts and inter-relationships, is exactly equal to these parts and relationships. The difficulty is in knowing whether one has accounted for them all. Most of the relationships seem invisible. But this is not necessarily the case. The brine shrimp, for example, can be thought of as a relationship between the algae and shrimp feces in the same way that a combustible engine is a relationship between gasoline and exhaust. The brine shrimp is the relationship between these two parts of the whole ecosphere. The feces inter-relates to the microorganisms and bacteria that break down the shrimp’s waste into inorganic nutrients and carbon dioxide that are again used by the algae that in turn provides sustenance for the shrimp. Like each of these individual relationships—complex in and of themselves—the brine shrimp is merely a collection of lesser parts—a system of inter-relations. These lesser parts are merely systems of inter-relations. At each level of scale (perspective), one can ‘zoom in’ and see inter-relationships and systems.
There are also many distinctions that can’t be ‘seen’ or ‘recognized’. For example, an important functional part of the ecosphere is the atmosphere that exists directly above the water. The water and the atmosphere are made up of gasses and molecules, each of which is a distinct part in a larger, organized and interrelated whole. The gravel, twig and glass provide important ‘surface area’ that ‘act as hiding places where microorganisms and algae can attach themselves’ (Ecosphere care 2006). The distinctions we make are not absolute. That is, they are each proximal in nature. For example, what the untrained eye might call a ‘twig’ is actually a coral called gorgonia. From the perspective of a biologist who studies gorgonia there would likely be many more complex and refined distinctions he or she would consider. Likewise, a physicist’s perspective, as Feynman explained, might see the glass globe as a ‘distillation of the Earth’s rocks’ (Hey and Walters 2003) and he or she might see the gravel as mineral deposits assisting in the delicate balance of the ecosphere. Each of these are systematized distinctions comprised of other inter-related distinctions and each of these organized systems of distinctions is dynamically changing according to where the emphasis is placed according to the perspective. Metaphors, similes and analogies are also types of perspectives that transform the organization of inter-relationships and distinctions of the whole system. For example, ecospheres are sometimes thought of as ‘biological batteries’ because they store light energy that was converted from biochemical processes.

Not all perspectives are from an observer outside of a system looking in. Not all perspectives are taken by actual people. Remember that each distinction involves a perspective. In addition, each distinction can be attributed a unique perspective. So, one might conceptualize the ecosphere from the point of view of the brine shrimp or the algae. And, we may not want to anthropomorphize these perspectives. That is, one may want to view the system as the shrimp ‘views’ it with all the sundry mental and sensory faculties of a brine shrimp; these may include actually seeing or sensing things that a human cannot, like tiny microorganisms that exist throughout the ecosphere and are critical in its functional balance. Or, one may want to make an anthropomorphic analogy between the shrimp and the human participants who lived in an actual, human scale ecosphere in Arizona called Biosphere 2. Or even humanity, those of us who are living, right now, in another ecosphere called Biosphere 1 (a.k.a., the Earth).

At each step along the way, we make choices about what to re-cognize, about what to include and exclude and from which perspective to view a given system. There are various distinctions, inter-relationships, organizations of parts and wholes, and perspectives; some of these are visible to the naked eye and some invisible. But there are many more that are invisible to the ‘mind’s eye’, limited by one’s knowledge of the shrimp, or the algae, or the glass or the system itself. Or, humans may purposefully limit themselves, knowing that taking into account the sun’s energy (a constant) in order to plan the next management meeting is unnecessary. These boundaries are drawn constantly; many more times than are conscious to us.

**ANALOGY: A GENERAL EXAMPLE OF DSRP**

The Ecosphere example helps to see the implications of DSRP in analyzing or thinking about an exemplar system. But let’s take a more abstract example, such as an analogy found on an SAT test, and deconstruct it using DSRP. The basic structure of an analogy is, A is to B as C is to D or in notation, A:B::C:D. The analogy ‘lawyer : courtroom :: gladiator : arena’ thus reads that ‘a lawyer is to a courtroom as a gladiator is to an arena’. DSRP can be used to deconstruct each of the four obvious distinctions in the analogy: (1) lawyer, (2) courtroom, (3) gladiator and (4) arena. For example, one might deconstruct the distinction lawyer to argue that not all lawyers correspond to the implied relationship (perform their job in) with courtrooms. There are many lawyers in the US who have never tried a case and who have never been in nor do they perform
their daily duties in, a courtroom. So a simple deconstruction of one of the more obvious distinctions in this analogy yields that for the analogy to work, we must be referring not to all lawyers but to a particular type of lawyer, typically called a trial lawyer. This distinction, between lawyers and trial lawyers is an example of how each of the more obvious distinctions in the analogy could be deconstructed even further thus ‘exploding’ the analogy into a very complex conceptual system. Ironically, it is this kind of fine-grain distinction making that lawyers often use in order to convince juries and win trials in courtrooms across America, so it might be the case that being a good trial lawyer has a good deal to do with implicit uses of DSRP.

There are many other less obvious distinctions in our simple analogy, as well as relationships, systems and perspectives. The ‘::’ and ‘::’ symbols denote relationships and each of the co-related distinctions form systems. Note that in order to get the answer right on an SAT analogy, the implicit relationships must be made into explicit distinctions. For example, in the SAT analogy below, the test taker must transform the implicit relationship between doctor and hospital into an explicit distinction such as ‘is found in’. Even then, further distinction is required because a ‘criminal is found in a jail’ (or at least a prisoner is), a ‘cow is found in a farm’ (or perhaps one might say, found on a farm), ‘food is found in a grocery store’, etc. In order to get the right answer, the test taker must therefore further distinguish the relationship as ‘works in’ in order to identify answer C as the right choice.

**DOCTOR : HOSPITAL ::**
- (A) sports fan : stadium
- (B) cow : farm
- (C) professor : college
- (D) criminal : jail
- (E) food : grocery store

The right choice requires a complex set of conceptualizations that require distinctions and relations but also systems and subsystems and even systems of relations. For example, the analogy, ‘doctor : hospital :: professor : college,’ like the lawyer example above, has four obvious distinctions and three implicit relationships that we make explicit in order to solve the problem: Distinctions {doctor, hospital, professor, college} and Relationships {works in, is analogous to, works in}. Each of these distinctions is a complex concept in and of itself with DSRP configuration that determines what is internal and external according to who is having the concept (in this case, the test-designer). So, for example, in order for the analogy to work as the test-designer intends, the test-taker must conceptualize each distinction in the question, as well as the answers, in a way that has some content-context correspondence with the test-designer’s conceptualization. Also note that each of the above are also systems made up of distinctions and relationships. Less obvious than the distinctions and relationships are the two systems:

- 
- ((doctor)—(works in)—(hospital))
- (professor)—(works in)—(college))

Note that there are six distinctions above and two of them are also acting as relationships.

Another system is the analogy itself:

- ((doctor)—(works in)—(hospital))—(is analogous to)—((professor)—(works in)—(college))
The analogy is completed, or is it? The problem with analogies such as these is that even the most obvious distinctions can be infinitely complex. For example, if one did a survey of doctors and professors and asked them, ‘What do you work in?’ one would presumably get all kinds of answers such as: ‘an office’, ‘an ER’, ‘chaos’, ‘a university’, ‘a clinic’. Not all doctors work in hospitals and not all professors work in colleges. Indeed, deconstructing the distinctions ‘in’ and ‘at’ will produce a wilderness of concepts trapped in these seemingly innocuous terms. Do professors work in or at colleges? Is a college distinct from a university? Are cows found on farms or in them? There are many such distinctions and relationships that can be made and many different systems and perspectives that can be taken. Of course, the SAT analogy is not suggesting that all doctors work in hospitals or that all professors work in colleges, so it is clear that C is the right answer. Or is it? Let’s look again at our analogy:

Doctor works in hospital is analogous to...
   (A) Sports fan works in stadium
   (B) Cow works in farm
   (C) Professor works in college
   (D) Criminal works in jail
   (E) Food works in grocery store

Option E is certainly the weakest possibility. D looks circumspect also, although most jails have work programs and most of the people in jails are also criminals. Not all doctors work in hospitals and not all criminals are in jails; the ones that are, are often called prisoners, but there are at least as many proximally similar synonyms for doctor as there are for professor or prisoner. Just as trial lawyers are a kind of lawyer that might be found working in courtrooms, prisoners are a kind of criminal that might be found working in jails. Therefore, it would not be inaccurate to claim that criminals work in jails because some do, just like some kinds of doctors work in hospitals and some kinds of lawyers work in courtrooms. It would also not be unreasonable to suggest that cows work on farms. There are working breeds of horses and dogs that work on farms. One could argue that cows get paid in grain in exchange for milk, offspring, manure used as fertilizer, or even flesh.

The point is not to torment the analogy unduly but to demonstrate what many educators know: that test performance is more often than not an indicator of the degree to which the test taker thinks like the test designer. If there is significant correspondence between content and contextual-configuration for the test taker and the test designer, then the test taker will do very well, but if the test taker’s contextual-configuration is DSRP-different, he will fail to select the right answer. For example, if a test taker grows up on a farm with a physicist or an economist father who defines work abstractly, simply as the expenditure of energy or the exchange of value; or if her mother is a doctor working in a family practice in a downtown office; or if his father is a corporate lawyer who has never stepped foot in a courtroom; or if her mom is an avid Yankees fan who also works at the stadium selling frankfurters; then these test takers might be prone to take a slightly different perspective on each of these distinctions and relationships and in turn alter the larger systems and relationships and in turn arrive at a different conclusion. Many of these different configurations of context can be quite innovative, perhaps even intelligent or wildly creative, but such answers will be judged to be incorrect on the test. The test designer may argue that it is obvious that doctors are more like professors than they are like cows and criminals; and further that hospitals are more like colleges than like farms and jails. Yet agricultural schools such as Cornell University actually have working farms on campus, but not hospitals. On and on it goes into a fuzzy network of concepts and DSRP configurations.
The takeaway from this discussion is that a simple analogy is actually a very complex conceptual system of which only a small fraction can be captured here. The analogy provides an example of a more abstract application of DSRP. It also demonstrates that the right answer involves a mapping of the test designer’s and the test taker’s DSRP-configurations of content in order to be graded correct. DSRP could be used by test takers to ensure that their answers share the same organizational structure as the test designer. The example also demonstrates how DSRP can be used to generate novel, original, creative or alternative explanations. In other situations, where creativity or originality is rewarded rather than penalized, DSRP can assist people to be more adaptive or creative. The example also demonstrates how DSRP can be used to explain how a test designer and a test taker differently conceptualize what appears to be the ‘same simple analogy’. Whether the object of similarity is an analogy, a movie, or a global event, different DSRP configurations can lead to very different interpretations or ideological implications. Because DSRP offers an explanatory model for how these interpretations differ, it may also provide a heuristic for identifying ways that they can compatibly coexist. Differences in conceptual systems (beliefs, ideas, or ideologies) are the result of either differences in content, patterns of context, or both. These conceptual differences lie at the heart of important practices such as: teaching, learning, and transfer by identifying the differences and similarities between the existing concept and the target concept; communication by finding correspondence between transmission and reception; and the general resolution of conflict of all kinds (such as the conflict between the test and the test taker above) by identifying synthetic alternatives that combine DSRP configurations. The example also illustrates how general cognitive schema such as analogies or metaphors are based on specific configurations of content and DSRP-based context rules that lead to extremely complex molar concepts.

**SUMMARY**

It has been suggested that the same set of simple rules applies across conceptual space and time. Justification for DSRP should be sought: (1) in correspondence with the direct knowledge and experience of conceptual systems, (2) in the success of DSRP as a framework for synthesizing and/or comparing varied conceptual systems, and (3) in the success of DSRP as demonstrated by existing and future empirical studies.

Reviewing each of these possible areas of justification in slightly more depth, it is proposed that direct knowledge and experience will reveal that conceptualization is a complex and highly adaptive process. The properties of such a complex adaptive systems (a complex adaptive conceptual system or CACS) are most likely the result of simple underlying rules. Experience gives us countless examples in which the same symbol or term is used in two situations and two entirely different meanings. If symbols can be used in this way, then there must be processing rules that organize meaning or context so that the content can be used in such diverse ways. Other concept and cognition scholars will no doubt be better able to critique the utility of DSRP in relation to number (2) above. The success of DSRP as a framework lies in its robustness and the potential for adaptive and emergent properties to result from application of simple rules with concepts as agents. Its weakness is that because it is a complex system, it is less tractable than other systems. DSRP may shed new light on other concept theories such as prototype theory and therefore be justified by its heuristic value. DSRP suggests that more conceptual phenomena can be explained with less, which points to its justification as a theory (i.e., Occam). It may also prove useful in areas such as interdisciplinary science or systems science in which scientists from many intellectual domains attempt to synthesize their academic tribe, culture, customs and language. Because DSRP offers a model for all conceptual systems it is also a framework for comparison and synthesis of conceptual systems. To be justified, DSRP will need to be demonstrated by
future empirical research. It should be noted that theoretical, empirical and practical examples exist for each of the individual patterns of D, S, R, and P and that this work is often transdisciplinary (occurring across different fields). An inventory of such works relating to each pattern has been amassed by the author, some of which were provided above as references. Future work should include evaluative and integrative reviews of this literature. Some of the above literature includes empirical research relating to each of the rules. What has not been empirically studied are the unique dynamics of the DSRP as an integrated model or the effects that training in DSRP might have on performance on tests of critical thinking, intelligence or creativity, for example. Experimentally, the effects of training in DSRP may be shown by studies using a standard test such as the IQ, creativity tests, or other specialized scales in order to test treatment and control group performance. The dynamics of DSRP are quite complex and may not be entirely revealed or tractable by experimental methods alone. In parallel, computational simulation is suggested. In addition, while experimental methods may be incapable of capturing the complex dynamics of DSRP as a whole, such methods may be useful in studies of the relationships between DSRP-pairings such as D and P or R and S, thus building empirical justification and extending the existing single-rule studies. As a theoretical construct, DSRP may also have wide application in computing as a new language or as an adaptation of existing languages. Future studies may include programming tiny concept-robots that communicate with each other using DSRP syntax and structure to split or lump together, form new virtual concepts and demonstrate adaptive conceptual behavior.

As a speculative theory of concepts, DSRP will not be justified by a single study but by multiple studies using a mix of multiple methods and measures. If the proposals herein are found to be valid, then DSRP holds promise for a broad set of theories and fields including: interdisciplinarity, group dynamics, cognition, creativity, education, theories of mind, identity, attribution theory, symbol grounding problem, computing, logic, evolutionary epistemology, concept theories, embodied mind theories, and the ubiquitous but vague notion of context.

Biographical Sketch

Derek Cabrera is a Visiting Fellow at Cornell University and a Research Associate at the Santa Fe Institute for the study of complex systems. Prior to his current appointments, he was a National Science Foundation Post Doctoral Fellow, Co-Investigator in the College of Human Ecology and a Lecturer in the Department of Education at Cornell University. He was a National Science Foundation IGERT Fellow in Nonlinear Systems at Cornell and a recipient of the Association of American Colleges and Universities’ K. Patricia Cross Future Leaders Award. He is the author of Remedial Genius, several refereed journal articles and book chapters.


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1 Unknown origin
2 The basis for a theory of concept ecology and mechanisms for evolutionary epistemology and context, among others.
3 It is interesting to note that the ideas of distinction and relation and system and perspective all center around our notions of spatial and temporal extension (as illustrated in the causal structure of rules). That is, DSRP views concepts as objects (albeit fuzzy ones) existing in space and flowing through time. The degree to which this is determined by general physical rules of computational dynamics and to which it is determined by how our minds have evolved to model causation within our range of physical experience is open to speculation.
4 The degree to which the DSRP rules and elements are implicit in logic is debatable, but it is suggested that perspective and the elemental relations of DSRP are to a greater degree implicit in logic.
5 It is remarkable how similar the dynamical structure of this conceptual universe is to that of our own universe. The cosmology of the conceptual universe is nearly identical to that of our observable universe, which began as a high temperature material soup and is going through a process of cooling and crystallization, resulting in the same network structure on the molecular and galactic levels.
6 The material application of psychology and sociology attributes a trivial or crude psychology of identity and traits to inanimate or material objects. For instance, a star is a big ball of hydrogen undergoing certain processes, but it can be regarded as ‘Star,’ with personality traits ‘big’ and ‘hot.’ It has the trivial psychological perspective, ‘I am Star. Planet is constantly tugging at me’ etc. This is a trivial psychology in relation to concept bags, but a psychology nonetheless. ‘Star’ also has a ‘sociology’ in that it interacts with, for instance, ‘Planet’ via gravity, etc. They move each other and distort each other’s shape, etc; in general they convey information to each other. ‘Star’ also has a sociology in so much as it affects the behavior of Carl the astronomer.
A NOVEL APPROACH TO THE CONCEPT OF SYSTEM INFORMATION

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ABSTRACT

This paper represents a novel approach to the system information correlating General System Theory, Cybernetic and the Theory of Information. The main objective is to investigate whether “information” is a subjective concept or an objective entity in the physical reality. In this quest, system has been identified as an abstract model for observation and the perception of the world by the human mind. Based on this definition, every phenomenon that can be observed or imagined is perceived as a system. Where there is a system, there should be an observer and hence there exist information in between.

Combination of system elements as a whole is explained by System Dynamics. Based on this assertion, the system is in a continuous change and transmutation; a conceptual process that is independent of time and space. In this perspective, time and space are conceived not as the background but the outcomes of the inherent dynamics of the system. It is shown how the time could be considered as sequence of events and the space as relation between system elements.

System structure is modeled based on Binary graph as the fundamental topology for combinatorial pattern of the system. A new System Algebra is defined, based on which the System Information Matrix (SIM) is introduced to demonstrate information imbedded in a system. This model is also used to evaluate the amount of system information based on Entropy as defined in thermodynamics and in the information theory. Complexity is another parameter of the system that is represented here based on multi-functionality of system elements. This new definition provides basis to quantify this feature of the system.

Cybernetic systems categorized as life, machines and composite systems with high degree of complexity such as human societies, are all shown to be distinguishable by exchange of information. In these systems, information flows through different components the same way as it would from any system to the observer. It is concluded that information realized by the observer is a relative objective entity in a system. However, in cybernetic systems having controllers as internal observers, the information is physical and objective regardless of any external observer.

Keywords: System Information, System Theory, Information Theory, System Dynamics, Information Matrix, Time and Space, Entropy, Complexity, Cybernetics.
INTRODUCTION

The term “Information” is extensively used in most modern human activities. We find this word almost everywhere, not only in its common meanings as being informed or getting the news, but also in some new concepts that view the Information as a material media handled by machines and technical facilities in many social affairs.

The later meaning reminds us of something like electricity or radio waves; a quantity measured in Bits or Megabytes, stored on a silicon chip, transferred by digital signals and processed in computing machines. Information seems as a physical entity with multitude of applications in Telecommunications, Broadcasting, Control and Automation, Computer Science, Genetics and other fields that use Information Technology.

Information is not actually a new term such as Electron, Laser or Gene in contemporary language. It has a historical background as old as human societies and languages. Information has found its meaning from the first pre-historical periods that man tried to use some verbal sound or visual symbols to acknowledge each other by exchanging the news and transferring messages. Then how has the meaning of this term nowadays developed from a conceptual quality to an objective quantity? Is there any measurable objectivity to information similar to those properties of material such as mass, energy, space and time or it’s a subjective category such as perception and knowledge?

Questions of this kind lead us to philosophical abstracts. In this brief we will focus on the objectivity of the information and attempt to clarify its relations with the matter. To achieve this goal, we will not enter deeply into the abstract philosophical arguments, nor will discuss the practical terms of computer science or communication technology, but will follow our objectives through the General System Theory that is a new perspective in the modern science.

General System theory together with the Information Theory and Cybernetics is one of those theories of the 20th century that has opened new windows to modern day science. These frontiers were achieved by the efforts of the great scientists such as Ludwic Van Bertalanfy, Claude Shannon and Norbert Wiener.

General System Theory introduces system as a general category with a high level of abstraction that is applicable to any phenomenon. Meanwhile, it considers the specific definitions of a system in different sciences such as physics, biology, psychology, sociology and economy. Hence, the system theory is considered as a bridge between philosophy and the modern sciences.

1. REALITY OF THE SYSTEM

System is perceived as a window for looking out to the world. In other words, here system is a model for observation or a tool for realization of anything inside or outside of the mind. With this meaning, system could be considered as a subjective concept dependent on the observer. But we can argue that System is not subjective because the solar system for instance, has had existed a long time before human appears on the earth to observe it. It is true, as we know, that sun and its planets had always co-existed by
their gravitational fields as a system, but if we think of their existence as objects by
themselves while excluding the human mind from the observation circle, what then
remains will be a formless type of absolute “existence”. From this view, the objects
only exist as abstract beings without any property to be assumed about them and
without any “Why” or “How” to be asked about their relations. Hence, the sun and
moon are “objective” as far as their absolute “being” is independent from us, but what
about their relations as a system?

If we dream that we are walking on a golden planet we can still talk about this
reality, but as a “subjective being”, because its existence totally depends on (or caused
by) our observing mind. Now a scientist (specially a theoretical physicist) may say that
a golden planet also is objective since its existence is not against the rules of physic and
it can exist even if we have not yet observed one [Ref.12].

For the science methodology, anything that is logically possible and/or potentially
observable is considered “objective”. That is why the mathematical entities such as
numbers or geometrical shapes are supposed as “objective beings” although they are
only abstract concepts. It is in this meaning that system and information associated with
it could be considered as “objective” realities.

2. SYSTEM PARAMETERS

As a simple definition, we can say that system is any being observed as a whole by
combination of its distinguished elements, and it is a dynamic entity that is always in
change and evolution. From this perspective, everything can be considered as a system,
whether it is subjective or objective, material or spiritual.

Every system can be distinguished by three main parameters as following:

a) Base is the collection of system elements regardless of their combination or
interactions. By this definition, “base” is the material or the substance within the system
that is a fixed quantity in a closed system.

Base is very essential to classify the types of different systems. For instance, the base
of a physical system is Matter in various formations. The base of a social system is the
human in the form of individuals or groups, and the base of a conceptual system is the
mental images, ideas and concepts.

b) Function is the sum of the interactions of all system elements and parts
(subsystems). Function is the major parameter of system that determines the reaction of
the system against its environment. A system with the same base may be considered as
different systems regarding its function. For instance, man is a mechanical system when
he is running, a biological system when he is eating, and is a social system when he is
speaking.

c) Structure is the formation of system elements in a framework set by the
intrinsic rules of that system. Therefore, the structure of mechanical systems is
determined by the rules of mechanics and that of organisms is set by the rules of
biology and biochemistry.
Any single element in a system can be considered as a system. In general, any object can be continuously divides in smaller parts and reduced to a system of smaller elements. Elements are subsystems recognized by their Bases and Functions. In other words, element is a stable system with a certain base and function that enables it to interact with other elements in that system.

Main parameters of the system as well as other parameters such as Boundary, Level, Layer, Subsystem and Element are simplistically illustrated in Fig.1.

**3. DYNAMICS OF THE SYSTEM**

System by its definition is a dynamic and active entity, so that the system concept is conceived by its dynamics. A general system theory could not be complete without representing an adequate description of the system dynamics.

Dynamics of a system is an abstract concept with a more general meaning than its motion in time and space. By this meaning, dynamics of a system is a category that includes any kind of change (transmutation) or evolution. The essence of this dynamics appearing in observation is a continuous conversion between the unitary concept of the system as a whole and the multiplicity of its consisting parts or elements.

To clarify this concept, let’s consider the simple system C as combination of two parts or elements demonstrated as A+B=C. As we see, in one side of this equation there are two entities and in the other side there is only one. Now in a logical sense two things cannot equal to one! This contradiction does not show up in the numerical quantities. That is, the arithmetic equation 2+3=5 always seems true. But for the system, it is a contradiction that can only be explained as the alternation between unity and multiplicity that provides the dynamics of the system. In other words, the two elements of A and B are united as the system C and, at the same time, the unique system C is divided in two individual elements A and B. Dynamics of system is the result of this continuous alternation between system as combination of parts and system as a unified whole.

As a physical analogy, we can observe this conversion in the process of ionization. In ionization, the molecules are divided into the free ions and floating in the electrolyte by the electrochemical forces. At the same time, the ions have tendency to join back together to rebuild the original molecules [Ref. 2].
4. COMBINATION AND MIX PROCESSES

Combination process of the system elements takes place according to the system dynamics. The simple principle that explains this process is the general laws of reflection and mutual effects as conceived by common sense. According to this principle, the two elements “A” and “B” of a system combine when “A” affects “B” by its function “a” producing a reactive function “b” in “B” and, at the same time, this reactive function “b” affects “A” in its own turn, so that neither “A” nor “B” can stay stable unless they join together forming system “C” with a new function “c”.

A combination is a reversible process conceived as either congregation or separation of elements. From the logical perspective of system dynamics, these two concepts are equivalent since there is no time direction in this process. Therefore, a combination shown as A+B=C in one direction could equally be shown as C=A+B in other direction. The core concept in this process is identity of the individual elements “A” and “B” that is always conserved beside the identity of “C” as the whole.

By the way, we can think of an irreversible or one-directional kind of combination called “Mix” process in which the initial elements lose their identity in the combination. That is, when two elements are “mixed”, they will loose their ability to separate back to their original elements and will remain as one element in the system. In other words, the mixed elements are replaced by a newly emerged element. As an example, mixture of Hydrogen and Oxygen provides a mixture of two gases that could not be easily separated. But combination of these two gases produces water and heat that could be decomposed to the primary elements by means of electrical energy.

As a basic condition for any combination, the two element or systems should potentially be capable to affect each other by their respective functions. This first condition is generally determined by the base and structure of the systems and the governing rules for their interaction. For instance, according to the natural rules of survival, a wolf hunts a rabbit while it does not hunt a tiger. As another example, Oxygen produces water when combined with Hydrogen while it will not produce the same results with Helium. There is also a second condition for combination of two systems or elements according to that they must either regularly or accidentally come in contact with each other. A wolf cannot hunt any rabbit unless it meets one. Also, Oxygen cannot synthesize with Hydrogen unless they are put together under certain physical conditions.

Both these two conditions are subject of probability and could be interpreted by a chance factor or probability denoted as “P”. According to this statement, there is a probability $p_c$ associated with functionality of any system like C that is a function of probabilities of its individual elements:

$$P_c=f(P_a, P_b) \quad \text{where } C=A+B \quad (1)$$

Hence, we can summarize these two conditions of combination by saying that “A” and “B” may combine as “C” if and only if:

1. “C” can essentially be a combination of A and B (Necessary condition): $P_c>0$
2. “A” and “B” can come in contact (Sufficient condition): $P_a>0 \ & \ P_b>0$
5. BINARY CONFIGURATION PATH

System configuration can be modeled as a combinatory pattern of the system elements using a binary path.

As a logical consequence of the combination process, the elements of a system combine in different stages called Layers. In the first layer, the process begins with mutual effects of only two bodies, forming a part of two, which can in turn combine with another elements or subsystems in later stages forming larger parts in the system and so on. It should be noted that these are logical stages with no time sequence considered for the process.

Binary combination as interaction of only two elements or parts is a fundamental concept in combination process and the building block of system structure. The reason is that a system of two elements is the smallest system, and two is the smallest integer number that can be divided into two other integers (2=1+1). Modeling of the system based on the initial combination of three or more elements is also possible, but they can ultimately be reduced to binary combinations.

Configuration path of a system can be represented by a graph of binary-tree as shown in Fig. 2. In this graph, the two-by two combinations of the elements and parts (subsystems) through their interactive functions take place in different “Layers” of the system structure. Therefore, binary path provides a hierarchical structure for the system in which each combination is taken place in a layer and the layers of the same number of elements are located in the “Levels” as shown in Fig 2 and Fig. 3.

6. SYSTEM ALGEBRA

When two or more systems integrate in a combination process, their bases add up as scalar quantities. That is, the base of the combined system is equal to the algebraic sum of the bases of the component systems. This fact is obvious in the physical systems from the conservation principles of the mass, energy, momentum, electric charge, etc. But functions interact more like the ambiguous vectors, so that there is no general principal for combination of the function, unless we say that the ultimate function of a system is somehow the outcome of all the partial functions of its elements. Hence, any mathematical formula used to represent the combination process must include these characteristics.
By introducing the operator $\perp$, we can demonstrate system combination by the formulas like $A \perp B = C$. The operating symbol $\perp$ in this formula means the base of $C$ is the scalar summation of the $A$ and $B$ bases and the function of $C$ is outcome resultant of the $A$ and $B$ functions shown as $a$, $b$, $c$ in Fig. 2.

There might always be elements that do not combine with other elements or parts of the system in some particular combinations. For these cases, we assume a fictitious neutral element, known as “Zero-Element” (0 or $A_0$) that extensively neutralizes the functions of the elements or parts to which it combines. Same a “Zero” in conventional multiplication, this neutralizing function of the zero-element is a contagious effect that extends from layer to layer neutralizing any further element or part that comes in contact with, so that the resultant system includes a bunch of non-combined branches beside the combined elements. (i.e. $B_1$ in Fig. 3)

Here, using the combination operator $\perp$ and the system zero-element “$A_0$” with its neutralizing function denoted as $\perp^0$, we introduce a special algebra for the system “$S$” combinations defined by the following basic principals:

a) Closure law: if $A_1 \subset S$ and $A_2 \subset S$ then $(A_1 \perp A_2) \subset S$

b) Commutative law: $(A_1 \perp A_2) = (A_2 \perp A_1)$

c) Non-associative law: $(A_1 \perp A_2) \perp A_3 \neq A_1 \perp (A_2 \perp A_3)$

d) Neutralization law: $(A_0 \perp A_1) = A_0^1$, $A_0^1 \perp (A_2 \perp A_3) = A_1 \perp^0 (A_2 \perp A_3)$

In system equations, elements inside parentheses indicate parts or subsystems. Symbol $\perp^0$ always locates out of parenthesis indicating a neutralized connection between elements or parts beside that.

By this special algebra, it would be possible to formulate any combination of system elements depicted as a binary-tree path.

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**Fig. 3. Binary path of an event in a five-element system**

Fig. 3 shows the binary path of one possible combination of six elements (five real elements and one zero element) in a system represented by an equation employing
system algebra. As indicated by symbol $\perp^0$ in this equation, $A_i$ neutralized by $A_0$ stays apart from the rest of combinations in this particular combination. This fact is shown in binary graph by dotted lines used for combination path of $A_i$.

7. SYSTEM EVENTS

Any combination of system elements holding the principles of system algebra is called an Event. System elements can provide many different events in this binary path. The total number of possible events in a system increases drastically by increase of the number of elements. This total number can be represented as a function of the numbers of system elements “$n$” as shown in equation (2)*:

$$E_n = \frac{k \times (2n)!}{n \times 2^n \times n!}$$ (2)

Employing this formula, the total number of all possible events for some values of “$n$” is estimated as following examples:

- $E_1 = 1$
- $E_2 = 2$
- $E_3 = 7$
- $E_4 = 37$
- $E_5 = 265$
- $E_6 = 2426$
- $E_7 = 27027$
- $E_8 = 3.55 \times 10^5$
- $E_{16} = 1.68 \times 10^{16}$
- $E_{22} = 4.91 \times 10^{12}$
- $E_{64} = 3.60 \times 10^{105}$

Recalling the probability factor $P$ in the combination process, we can say that any event $e_i$ of a system is associated with a probability that could be determined as a function of the individual probabilities of the element in that event.

$$P_{e_i} = f_i(P_{A_1}, P_{A_2}, P_{A_3}, ... P_{A_n})$$ (3)

Based on this definition, different events of a system have different chances to occur, and a system normally happens in its most probable events. In other words, the events of a system for which $P_{e_i} = 0$, are basically impossible to happen and are eliminated. Many other events having low probability might never find chance to happen in the system’s life. Therefore, in a real system most of these combination possibilities are eliminated according to the rules and structure of that system.

System is a dynamic entity that does not appear as only one event, but occurs as a sequence of various events. A system of “$n$” elements appearing in “$t$” sequential events can be represented as following set:

$$S_{n,t} = \{(A_1, A_2, ..., A_n) \setminus e_1, e_2, ..., e_t\}$$ (4)

The notation means that the elements $A_1$ to $A_n$ of system $S$ are combined to form events $e_1$ to $e_t$ sequentially from 1 to $t$. Note that order of the events is essential for every unique system. Thus, a system by this definition is a set of sequential events occurring in a particular order.

*) This equation is obtained considering the fact that for each event in a system of “$n$” elements, number of nodes or branches “$m$” in its binary graph is $m = 2n + 1$ including the zero element. To add one element to this system, there will be “$m$” locations for this new element in each original event, to make a new event. Hence, number of events in the new system will be $E_{(n+1)} = (2n+1)E_n$ or $E_n = (2n-1) E_{(n-1)}$. Assuming $E_0 = 1$ we can make a
sequence of the number of events $E_i$ in which continuously substituting $E_i$ by $E_{(i-1)}$. Therefore, with some manipulations, the number of all possible arrangements in the binary tree will appear as: $E_n=(2n)! / 2^n n!$

Now, considering similar combinations produced by separating function of zero-element proportional to $n$, the identical events could be eliminated by a factor of $k/n$. In the above examples, $k$ is estimated as 1.4 for $n>3$.

8. SYSTEM INFORMATION MATRIX (SIM)

System defined as the sequence of events demonstrated by the binary paths can be represented by a three dimensional (3D) matrix called SIM. Every event of a system is represented as a two dimensional (2D) matrix. The columns of this matrix represent system elements and the rows show the layers of combinations of elements in that event. It can be proven that the number of parts or layers corresponding to the nodes in a binary path is equal to the number of elements of that system, thus, making this matrix square. As an example, the 2D matrix of the particular event of Fig.3 is shown in Fig. 4 below.

As shown in this example, in each layer of this matrix the states of participating elements in combinations are designated as number “1” and state of uncombined elements as “0”. Zero element $A_0$ located in the first column always appears as 1 in the first layer 0, and as 0 in the last layer. Layer numbers “$\_i$” in this matrix are sequential from “0” to “n”, and level numbers “$i$” are equal to summation of the numbers “1” in each row. Any layer “$\_i$” located in a certain level “$i$” represents a part or subsystem with combination of “$\_i$” numbers of active elements designated by number “1”. The sum of the numbers in a column “$\_j$” represents the frequency of participation of a particular element in that event. For instance, $\_0=2$ shows that zero element has been activated 2 times and created 2 separate parts in this event. The activity of elements in this matrix appears per priority of the order of elements in the sequential layers. That is for instance, the $A_0 \perp A_1$ combination comes in layer 1 prior to $A_3 \perp A_4$ in layer 2 since 0 is prior to 3. These rules make it possible to depict each event as a unique matrix and
obtain required information to rebuild relation of elements in that event as a binary graph or represent it as a system equation.

Referring to the probability factor \( p \) in formula (6), if the probability function \( f_i \) is known, we may use the real values of \( p<1 \) instead of 1 in this matrix, showing the probability of the event in the last layer as the function (mostly as a product) of the probability of individual combinations in that event. However, for the events of the past that have actually happened, we can always assume \( p=1 \) for the occurred and \( p=0 \) for all other non-occurred combinations as shown in the above example matrix.

For a system in which no separation between its parts is assumed, it will be easier to ignore the zero element and simplify the SIM for that system. As a simple example, Fig. 5 shows the 3D-SIM for a non-separate system of three elements in three periodic events together with the algebraic formulas and the binary paths of those events.

![Fig. 5. Matrix of Information for a 3 elements-3 events system \( S_{3,3} \): \( \{ (A, B, C) e_1, e_2, e_3 \} \)](image)

System Information Matrix (SIM) contains any information about the structure, functions and elements of a system. Element is a stable part in a system. However, an element is also a system that may decompose to smaller elements increasing the total element of the main system. Also in opposite way, any part or subsystem that is always repeated with the same configuration of certain elements can be considered as a stable element in that system. These phenomena always happen in the nature when molecules of mater decompose to smaller molecules or atoms, and in the opposite way, when some parts or elements are composed in larger structures to provide the material objects. Consequently, number of elements in a system is a relative quantity depending to the viewpoint of the observation.

**9. SEQUENCE OF TIME**

From the perspective of modern science, everything can be expressed in terms of the relation between objects and not between an object and some predetermined background [Ref.11]. From the system point of view, time and space are not
preconditions (a priory) for system dynamics, but some system properties that can be defined as the consequences of the system dynamics.

We have defined the system as a set of events that happen sequentially. From this point of view, *time is the sequence of the system events in the same order as they occur.* As explained in the system dynamics, system is both a combination of parts and a unique entity appearing as a whole. In fact, system is the subject of observation that alternatively appears as a whole and as the parts. In this alternation, the elements disappear when the system is observed as a whole, and re-appear when it is distinguished by its parts, each time as a different event with a possibly different arrangement of elements. Here is where time is generated when system jumps from one event to other.

We, as the observer and human beings are biological systems with a natural sense of passing time. In reality we live in the moment of present, while we can memorialize the past and imagine the future. We are even capable to conceptualize the time as a forth dimension in which a subject is visualized as a set of lined-up events all existing at once. In fact, what we actually observe is a “Becoming” world whereas we conceptually perceive it as a “Being” world. If the world is really a “Being” one, then it should be timeless, a system that its events exist all together at once.

From our observing point of view, events of the past have certainly happened, while an expected event of the future may or may not get chances to occur. Hence, we can say that for an observer, certainty is assurance of the past while probability is a matter of uncertainty about the future. In this regards, we can say that probability is not an inherent property of the system, but it is the fact of observation related to the lack of information about the system in [Ref. 13].

Time is usually considered as being coextensive with “Causation”. From the system perspective, “Causation” principle is not always concerned, and we do not necessarily have to explain every event as an inevitable consequence of the previous events or to consider it as a cause for the following events. This assertion may have different interpretations for different systems, so that the validity of the causation principle may depend on the type and the size of the system. For instance, events in the macroscopic world could be explained based on causation as defined for instance by the Newtonian mechanics, while this principal has not the same significance in the subatomic events as interpreted by the quantum mechanics.

10. SYSTEM SPACE

Similar to the time, space also is not a precondition for the system dynamics but can be perceived as a byproduct of that. Space is all about relation between objects and the way they are located beside each others [Ref. 8]. We already demonstrated these relations in the format of a binary graph. Here also, we can consider the space as a topological network produced by superposing of total binary graphs of all system events (Total Space). This provides a large multilevel network of nodes and branches on which the system appears at any time on a binary path. This superposing network which we can call it Supernetwork is actually a space-time manifold, because it is an overall pattern for all system events during periods of time.
As an example, supernetwork of a system with three elements is illustrated in Fig. 6. In this simple topological space, the elements are located on the vertices of a triangle, second level subsystems on the sides, and the ultimate system in the center. As “n”, the number of elements increase, the supernetwork topology gets more complicated.

![Diagram of a three element system as the superposition of its three events](image)

Fig. 6. Topological space of a three element system as the superposition of its three events.

Real systems do not usually possess all possible events of their total space, but only a portion of the total network can be considered as the Real Space determined by the rules and limitations of that system. This makes the supernetwork of real space less complicated than that of total space since most branches are eliminated due to real connections in the system. Real systems in the nature have definite structures and usually display a periodical behavior or repeating motions in their real space. For instance, the atoms of any element having certain number of electrons and nucleons all provide the same spectrum indicating similar interactions between their subatomic particles. As other examples, the years follow the same repeating seasons by the periodical revolution of the earth around the sun, and generation of species on the earth is repeated for long periods according to the rules of genetics.

In a homogenous system with symmetrical structure such as crystal or fractal, the space network shows repeating textures in all levels. In this case, the lowest levels of this network after which the combination pattern is repeated, could be considered as a model space that typically demonstrates all direct connection of elements and parts.

It should be noted that the system space is a mathematical concept that is different from the physical space. Physical space, as the relation between physical elements, is not apart from the physical objects. In other words, space is realized as a physical reality that its parameters could accurately be measured by implying mathematical models such as Euclidean geometry. Now, if we consider a geometrical space as a symmetrical system consisting of abstract elements such as dots, lines, planes and volumes then the physical space to which this geometry is assigned could be better realized as a supernetwork or a System Space.

11. GEOMETRY OF SPACE

In order to represent a geometrical space as a system, we have to re-identify main geometrical parameters of a space such as dimension, extension, continuation, distance, neighborhood, etc. in the symmetrical structure of simple spaces such as lines, planes and volumes, and generalize them to a multi-dimensional space.

Starting with a line as a one dimensional system, if we cut a line “L” in two sections, we will have a system of two elements “L₁” and “L₂” joined in a common point O.
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In this case, the network can be represented as a combination of two parts in one event as shown in Fig.7-a1. Since the line is continuous, it can be infinitely divided in parts, so that its elements become as small as points, while they are still tiny lines. In this case, the first level combination network of a line could be depicted as a chain of nodes in which any element is connected to only two other elements (1-pair) on that space (Fig.7-a2). This set of two elements called the Neighborhood identifies Extension of elements in two opposite Directions. Hence, we can say that a system has a 1D space if the neighborhood of each of its elements includes 1-pair of nodes on the network of its system space. Number of branches between any two nodes on this network space determines Distance between two points on that line.

Now we consider a plane as a two-dimensional system. Unlike the line, plane is divided by a line (l1) that is a one-dimensional system consisting of two line pieces connected through the point O. This plane could also be divided with at least one other line (l2) crossing at the same point O on the plane. Hence, two lines are alternatively cutting the plane, and two times two (22=4) plane pieces are produced. The plane system in this case can be represented by combination of the produced sectors P1, P2, P3, P4 as two events as shown in Fig.7-b1.

Fig. 7. Network space of Line, Plane and Volume as geometrical spaces.

Same as the line, any of those plane sectors could repeatedly be divided in four sectors utilizing pairs of crossing lines. If the same crossing lines cut the adjacent areas in the plane (i.e. in Cartesian Space) each sub-sector will have no more than four other areas in its neighborhood. In this regards, the plane could be depicted as a net of nodes and branches in which any element is connected to only four other elements on that space (Fig.7-b2). This neighborhood of four elements identifies extension of each element in four directions so that we can say that in a 2D system the neighborhood of each element includes 2-pair (four) nodes on the network of its system space.

Similarly, three planes cut a volume in eight (23) segments (Fig.7-c1) providing a network space with six directions as illustrated in Fig.7-c2. Hence, we may generalize these rules to say that a system takes place in a nD space if the neighborhood of each of its elements includes n-pairs of nodes on the network of its system space.
It should be noted that all systems do not have a symmetrical structure like a geometrical space, and it will not be easy to determine dimension or other parameters of their spaces. But, by studying the properties of their non-homogenous networks, it might be possible to represent dimensionality of these systems as a decimal number similar to what has been defined as the fractal dimension.

**12. ENTROPY**

Entropy is a significant parameter of the system and a measure for the information embedded in the system. Entropy was first introduced in thermodynamic as a measure of an energy that is unavailable to perform work in a process [Ref. 7]. As a physical system cools down and the temperature of its difference parts moderates, its entropy increases and the system lose its capability to produce work. Studying the statistical relations of the system elements such as gas molecules has revealed that entropy can be considered as a measure for disorder of the system elements. In other words, the higher is the entropy the less system elements are in order and less information is available in that. This interpretation provides links between the two concepts “entropy” and “information”. In this term order and disorder are relative concepts depending to the way an observer determines system parameters.

As an example, consider a closed system consisting of numbers of balls $B_1$, $B_2$, ...$B_n$ filled with gas molecules of various temperatures $T_1$, $T_2$, ...$T_n$. The balls having different kinetic energies are moving around and randomly hit each other, the same way as the gas molecules do in a gas container. When two or more balls get in contact they exchange some amounts of thermal and kinetic energy depending to the coefficients of their elasticity and heat conductivity. Fig.8 shows four possible events in this system.

![FIG. 8. Increase of entropy in a gas system during four even events.](image)

We can assume that under some random circumstances such as a specific collision, the collided balls penetrate each others so that their skins open and rejoin as a single surface. When this happens, the gas of two balls are Mixed and a larger ball is emerged with total mass and energy, and the average temperature of the primary gases of those mixed elements. This new element is shown as $B_{1,2}$ in the $e_4$ event in Fig.8.
In this event, the two gases with different classification as B1, B2 are mixed in an irreversible process as already described. They have lost their identity as individual elements and could not be distinguished from one another anymore in the system. In other words, their information is lost, although may not be destroyed. Their molecules of the primary elements are now moving in a larger space of randomness and ambiguity. Consequence of this process is that as the time passes number of system elements (floating balls) decreases while the total amount of its mass and energy will not be changed.

From the thermodynamic point of view, entropy of this system increases over the time by moderating its temperature and distributing its energy over the whole system. This process is a general tendency of the nature that happens almost everywhere in universe as determined by the 2nd principle of thermodynamics.

13. VOLUME OF INFORMATION

Entropy is a controversial category as defined in thermodynamics and in the information theory. System entropy in this regards is usually considered as the information in the system that is invisible to the observer [Ref. 3]. Therefore, the visible or available information in the system is called Nontropy or Negentropy [Ref. 1] to be consistent with thermodynamics definition of this term.

According to the Shannon’s Theory of Information, the available information in a system (Negentropy) is the value of information in Bit, required to identify the status of the system through all its possible situations [Ref. 4]. Similar to the entropy calculations in thermodynamics, this value of information is also calculated statistically. That is, if the probability of occurring of a system in a certain event ei among its all possible events is “P_i” then the value of information of that system “H” is the number of the bits of information needed to recognize that event, and it is calculated by following formula considering the based-2 logarithm of all probabilities [Ref. 7]:

\[ H = - \sum_{i=1}^{n} P_i \log P_i \quad \text{where:} \quad \sum_{i=1}^{n} P_i = 1 \quad (5) \]

In this formula P_i is the probability factor of each event, and \( n \) is number of all possible events of a certain system as determined in the equations (2), (3) and (4).

Systems usually do not occur with the same probability in all of their possible events and they follow a certain Pattern of Probabilities that depends on their structure and the dominating rules. But for many systems with random configuration such as gas molecules or motion of the balls in our last example, the probabilities for all possible events could be assumed as equal and non-zero. Hence, all terms within _ in equation (5) will be equal and the formula will be simplified as following:

\[ P_{e1}=P_{e2}= \ldots =P_{en}=1/E_n \Rightarrow H=-t(1/E_n)\log(1/E_n) \Rightarrow H=\log E_n \quad (6) \]

If we apply equation (6) to the number of all possible events \( E_n \) in equation (2), utilizing Stirling’s approximation for the logarithm of factorials as: \( \ln X! = X\ln X - X \) [Ref. 6], then the volume of information for systems with large number of elements could be roughly estimated as following:
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\[ H = \log E_n = \log[k(2n)!] - [n + \log n + \log(n!)] \implies H \sim n \log n \quad (7) \]

As formula (7) shows, the value of available information in a system (H) varies in the same direction as the number of distinguished elements in that system. As the number of elements decrease, SIM gets smaller, diversity of possible combinations in the system is reduced and less information gets available to the observer.

Reduction of number of parts in a system is usually the consequence of a mixing process in which the entropy increases as we saw in the balls example. Meanwhile, in a symmetrical system with low entropy such as crystal in which the combination pattern is repeated in certain levels, information is not actually decreased or lost but it is concentrated in some computable format known as Algorithmic Complexity.

14. COMPLEXITY

Complexity is a category that is simple to express and complicate to define! This is a controversial concept that can be interpreted from many different perspectives. An unknown problem that looks complicated in the beginning becomes simple after being solved, and a digital watch having less devices than a mechanical one includes more complexity since it is comprised of more advanced technology.

Complexity is usually considered as the property of systems with compact information that can be expanded in a Computational process. By this interpretation, there is more complexity in a compact disk containing the whole content of a book than the book itself. Also, a computer program generating figures of a large set by a few programming sentences is the subject of complexity [Ref. 10].

Now let’s consider this category from our system theory point of view. System as per our definition is sequence of some events. We may think that the complexity of a system increases as the order of its elements gets more complicated. But the order of system elements is determined by entropy and we should not confuse it with complexity. In this regards, let us compare the various states of the load of bricks used in a building. How could one claim that they have more complexity when regularly packed in the store, randomly dumped in a pile at the construction site, or orderly laid out in the building? The key answer might be in the functionality of the bricks in these different events.

System function as we defined is aggregation of individual functions of system elements in a hierarchical structure or radial binary-tree path without any loop. But we can also talk about the Multi-functional systems in which some elements having two or more simultaneous functions interact with more than one other element or part at a time. This generates closed loops in the binary paths of system events. A closed loop implies feedback to which an element adjusts its position against two or more other elements. This self-adjustment implies a form of computation that creates complexity.

There are many examples for multi functional systems. A person who is member of different associations is a kind of multi functional element. Roaring of a lion that is attractive for its mate and frightening for other animals is an example of multi-
functionality. Complementary behavior of photon as wave and particle as expressed in quantum physics could be considered as multi functionality of this particle. Also an electrically charged massive substance such as a proton that is involved in different force fields of gravitation, electromagnetism and nuclear at the same time is another example of multi functionality since no unified field theory is elaborated yet.

It should be noted that time-simultaneity is a subject of observation and it is relative. Sometimes two very close events seem to be simultaneous while there is very short time interval between them. However, we can think of events happening in chaotic condition for which the terms “before” and “after” have no meaning. Conditions such as extremely dense environments like black holes, or ultimately fast motions close to the speed of light \((3*10^{10}\text{cm/Sec})\), or times shorter than Plank’s time limit \((10^{-44}\text{Sec})\). These are some physical cases that can be considered as Actual Simultaneity.

Now imagine a small system of three elements A, B, and C in which B is a bi-functional element that makes a loop with two other elements in an event \(e_1\) as shown in figure 9. We can consider this event as two actually-simultaneous events \(e_{11}\) and \(e_{12}\) and call them sub-events. SIM of this event will consist of two parallel matrices each associated with one sub event. The number of sub events in a system depends on the number of multifunctional elements and the degree of their multi-functionality that can be Bi-functional, Tri-functional, Quadra-functional etc.

![Fig. 9. Multifunctional System](image)

Multi-functionality of elements settles information in the new dimensions as shown in the Fig.9. These additional dimensions of SIM represent degrees of complexity that could be considered as a measure to quantify this parameter of the system. If we
compare this complex system with the simple one shown in Fig. 5, we will see that the
two events of that simple system are compressed here in one event consisting of two
components (sub events). In this case, the total number of possible events is reduced
from 3 to 2 and complexity increased while entropy or value of system information
correlated to number of system elements is not changed. In this complex system \( b_c \) and
\( b_e \), the coincident functions of B, are balanced so that we can say one is computed as
the feedback of the other.

Complexity in this sense is about functionality and quality of system structure while
entropy depicts the variety and quantity of system elements. This complexity may
sometimes dictate that the adjusted elements get more in order and the entropy of
system decreases over the time. This is the case that happens in the natural bio systems
or in general to those systems recalled in Cybernetics.

15. CYBERNETICS

Cybernetics introduced by Norbert Weiner in the mid 20\(^{th}\) century as the science of
control in the nature and machine, considers the motion in the controlled system.

Controlled system is a system that follows a certain goal by a function that is
controlled through a feedback loop [Ref. 9]. The specific feature of these systems is that
they have a particular part or a subsystem as Controller that controls the system function
to achieve the identified goal by supervising the arrangement of the system elements
according to a pattern called Algorithm. Controller in this term can be considered as a
sort of observer inside the system that collects and develops system information. The
consequence of this process is that the system elements are driven to approach a certain
order, entropy of system decreases, and value of the available information in the system
increases as time passes. Main parameters of a cybernetic system are shown in Fig. 10-a
below.

Controller “C” in this system is a Multi-functional element that simultaneously
interacts with the algorithm and the body of the system. Superposing these simultaneous
functions provides a closed loop known as feedback that is the main feature of a
cybernetic system (Fig. 10-b).

Fig. 10. Cybernetic System
In the conventional systems as we show, information is a parameter of the order of system elements correlating to the system entropy. It means that anything conceived as a system contains values of available information that can be measured in terms of entropy and represented in the form of SIM. We can call this as Formal information since relates to the formation or configuration of system elements. In this term, formal information is not an active parameter of the system and is not a cause of changes in the system, but varies itself as entropy or distribution of energy in the system increases or decreases and the order of system elements changes over the time.

In the cybernetic systems in other hand, there is a kind of observer inside the system that re-arranges the order of elements by running active and energetic information between the parts of the system. Hence, we can say that the information in a cybernetic system is not only a static or formal parameter such as in the physical systems but it is a dynamic parameter with values of complexity and quality that takes an active role in driving the system towards a more complex organization.

CONCLUSION

In this synopsis, a new perception about the system information was introduced from the perspective of general system theory. It was shown that intrinsic system information maybe modeled as combinatorial patterns of system elements using binary configuration paths. A novel system algebra was introduced and utilized as a tool in formulation and analyses of system events based on System Information Matrix (SIM) defined here. Time and Space have been interpreted from the perspective of this system theory as relation between system elements and its parameters.

We also showed that information in a system is a relative parameter dependent to the position of the observer. In other words, the value of the information depends on the way that system is identified by its elements and their combinations. We showed that the value of information contained in a system is directly related to the number of elements of the system and the level at which the system is being observed. Therefore, the deeper we go into the structure of a system the higher would appear the information within the system.

Information by this interpretation is an objective entity since it is an interpretation of formation of system elements. It is an objective category existing by itself, although it is a relative quantity viewed by an observer. Here we have to distinguish between the terms “objective” and “relative”. That is, space, time, and mass are relative values while they are still objective realities. As we have learned from the principles of the quantum theory and the theory of relativity, many physical properties and effects are relative quantities and depend on the position of the observer [Ref. 5]. The same argument is valid about the information. In fact, if we argue that “objectivity” refers to what exists absolutely independent of the observer, then we would not be able to justify other properties of material such as mass, time and space as objective categories. By a counter argument, if we can say that these material properties are objective entities that can exist in the absence of the observer, then the same can be said about information.

Now, in the cybernetic systems and particularly in the natural bio systems that have been evolved independent from the human control, interpretation of this category
“information” can be different and even more definite. With the cybernetic system there always exists an observer (controller) inside the system that processes the information. Without information there would be no control. This information may still be related to the observer, but its observer is a part of the system. Thus, we can say that in the cybernetic systems, information exists independent of an outside observer and hence it is more certainly an objective entity.

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SYSTEMS THINKING FOR TEAM AND ORGANISATIONAL LEARNING
CASE OF PERFORMANCE MEASURE CONFLICTS IN A
MULTINATIONAL SUPPLY CHAIN

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ABSTRACT

Performance measurement and management have received great deal of attention in the literature in recent years. However to date, there is scant attention to dynamics and trade-offs amongst performance indicators in theory and in practice (Santos, Belton et al. 2002). Thus, performance management systems (PMS) have remained static, fragmented, and backward looking (Bourne et al. 2000) leading to adverse outcomes, often unknown to managers and organisations. A systems view of performance, on the other hand, calls for a holistic approach to performance measurement integrating multiple dimensions, functions and time horizons across the enterprise. A systemic performance measurement would take into account the interdependencies of functions and their dynamic influence on the performance of the organisation as a whole. This paper addresses this challenge using the four level thinking (Senge, 1991) and causal loop models to highlight the inter-relationships between the KPIs and their trade-offs within and across different functions. The study reports on an action research within a multinational company where through real case scenarios we demonstrate how KPIs influence, contribute or impede one another in a manufacturing/supply chain setting. The paper reveals how the use of systems thinking concepts and causal loop models by novice users facilitated an open environment for cross-functional communication and collaborations, leading to team and organisational learning and enhanced performance.

Keywords: performance measurement, team learning, mental models, systems thinking, cross-functional management

INTRODUCTION

“Not everything that can be counted counts and not everything that counts can be counted.” Albert Einstein

Numerous frameworks have been proposed to help organisations define indicators that reflects their objectives and assess their performance. Examples include Performance Pyramid (Lynch and Cross 1991), the Balanced Scorecard(Kaplan and Norton 1992) and Performance Prism (Neely, Admans et al. 2002). Recent literature indicates a shift from treating financial performance as the foundation for performance measurement to treating them as one among a broader set of indicators. The new performance measurement frameworks aim to connect performance indicators to business strategy and are designed to be multi-dimensional, explicitly balancing both financial and non-financial measures, both leading and lagging indicators to overcome the limitations of the traditional financial measurement
systems. However, a key criticism of current performance measurement frameworks is their static nature (Todd 2000).

KPIs are widely used by organisations to track actual performance against targets to assist decision making. Although the use of KPI is prevalent, there remains an underlying complex problem of correctly identifying and addressing trade-offs between a set of KPIs. Maani and Li (2004, 2005) suggest that too many KPIs could lead to over-reactions and over-intervention with adverse unintended consequences for organisations. This is because KPIs are often viewed as ‘linear’ - without paying due attention to interactions amongst them. In addition, far too many organisations still define their performance measures without understanding the dynamic interdependencies and trade-offs between the individual or groups of indicators (Santos, Belton et al. 2002).

The existing literature on performance measurement and evaluation appears to have overlooked the critical dimension of trade-offs between the performance indicators and strategic objectives. Trade-offs are inherent in complex systems - in particular in a business, social and policy environments. Understanding the dynamic interactions between KPIs allows decision makers to prioritize conflicting interests and objective and to achieve greater enterprise wide result.

**Literature Review**

The prevailing performance management systems tend to be driven by short term goals and local optimisation (Neely, P et al. 1999; Youngblood 2003), discouraging continuous improvement and learning (Lynch and Cross, 1991) and lack external focus (Kaplan and Norton, 1992).

Catellano, Young et al. (2004) identified seven fatal flaws of performance measurement outlines below:

1. Ignoring the Performance Contributions of Interactive System Elements
2. Misunderstanding Variation
3. Confusing Signals with Noise
4. Misunderstanding Psychology
5. Confusing the Voice of the Customer with the Voice of the Process
6. Failure to Support a Process View
7. Misunderstanding the Real Role of Measurements

Most organisations and managers, by extension, treat different elements of performance as independent and in isolation. This stems from a lack of systemic and integrated view of their organisational units leading to silo mentality and internal competition. "Unless performance management has an enterprise scope, an organisation cannot synchronise measurement across departments and gain true visibility of business performance” (Bourne, Mills et al. 2000; Castellano, Young et al. 2004).

Furthermore, the real role of performance measurement is often misunderstood. Often managers are so consumed with lengthy data gathering and mindless micro management that they lose sight of broader organisational objectives and strategy.
This could lead to proliferation and over-complexity in performance measurement systems (Johnston, Brignall et al., 2002).

**Performance Trade-offs**

The concept of trade-offs is not new. However, there is no consensus amongst researchers as whether or not they are avoidable. Skinner (1969) first proposed the trade-off theory and defined that trade-offs are unavoidable in the competitive business environment. Organisations are constantly competing along multiple objectives therefore it is argued that higher performance in one objective can only be achieved by compromising the performance of another. Santos, Belton et al. (2002) state that trade-offs between performance indicators are inherent in the business environment. If there are multiple objectives for an organisation, then by definition they must be conflicting, otherwise there would only be one objective (Youngblood 2003). Slack (1991) believes that trade-offs exist only in the short run; they can be eliminated in the long run. However, Silveira and Slack (2001) suggest trade-offs do exist and they can only be lessened but not eliminated.

Collins (2001) on the other hand suggests that organisations should abandon trade-offs and replace them with an approach to complement competitive objectives. He maintains the ultimate aim of organisations should be focusing on satisfying customer needs by achieving *all* competitive objectives.

Ferdows and de Meyer (1990) take a middle ground suggesting that trade-offs do exist but the trade-off theory does not apply in all cases; instead it is a function of progressive development of each performance dimension upon the others. They state that in the short term, it is possible to trade off capabilities against one another, but in order to construct long-term capability, management must develop the four objectives of quality, dependability, speed and cost in a ‘sand cone’ fashion where the lower layers must be extended in order to support any increase in any higher layer.

**Research Model & Methodology**

The research approach used here is the Four Level Thinking Model (Senge, 1991, Maani and Cavana 2007). This model consists of four distinct but related levels: events, patterns of behaviour, systemic structures and metal models (Figure 1). It is argued that most management and policy actions unfold in this manner, where events represent the shallowest yet most visible level of reality and mental models reflect deepest and most profound assumptions, norms and motivations (i.e., individual as well as organisational culture).

The research methodology employed was action research within a multi-national food company (referred to here as FoodCom) where one of the authors is employed as the supply chain planner. Six scenario were studied in detail. For each scenario the researcher began by observing and documenting relevant events and historical patterns over an extended period (several months). Following extensive discussions and focus group meetings with the stakeholders the researcher constructed a causal
loop model representing systemic structures - the forces and dynamics that had influenced the patterns of behaviour in the system.

The constructed Causal Loop Diagrams (CLDs) were then validated through follow up interviews with key participants. Following the validation of the CLDs, recommendations were formulated to suggest possible actions for improvements. Company participants were also asked to brainstorm on possible leverage points for interventions.

Finally for each case scenario, the researcher probed deeper into the mental model of the stakeholders (i.e., their assumptions, norms, views). In this paper we present two case scenarios in relation to performance measure conflicts and trade-offs in FoodCom’s supply chain. The recommendations derived from the discussions are illustrated at the end of each scenario to improve or overcome the problem situations.

Figure 1: Four levels of system thinking

Case Scenarios
From the field notes taken during interviews, informal discussions and document research, the problem situations and key variables were identified. Stakeholders’ views and thoughts were also sought to construct a conceptual model. The problem situations were summarised into different scenarios to demonstrate the interaction between KPIs and the complex issues that FoodCom’s management is currently facing. The scenarios identified highlight how functional teams interacted within the supply chain and how KPIs governed by different teams contribute or impede each other.

Scenario One – Urgent Devanning (Fixes that Fail)

Events

In mid 2006, FoodCom’s Supply Chain (SC) team organised a team meeting to discuss certain events which were of concern to the managers, as follows:
- Goods receipting time had increased from five days turnover to nearly eight days. Goods receipting time can be described as the time it takes for the products to be devanned (moved out of the container), palletised and receipted into the system.
- Out of stock (OOS) products had noticeably increased since March 2006 and accelerating thereafter.
- Warehouse and distribution staffs frequently complained about the workload and stress.

**Patterns of behavior**

Figure 2 - BOT for Out of Stock in Scenario One

By looking at the trend over time, the OOS situation is increasing continuously and the effort of instructing urgent devanning and putting more pressure on inwards team is making the situation worse. More and more products become OOS and inwards team is under a lot of stress.
This scenario is a classic "fixes that fail" archetype (Senge 1990) where well intentioned actions could cause unintended and often harmful consequences.

Historically, FoodCom has several products that routinely face out of stock (OOS) situation and leads to a low Case Fill Rate (CFR) – customer service level. In order to fix this, the supply planners request for warehouse and distribution to organise urgent devanning, so the OOS product lines can prioritised and receipted into stock to meet the customer orders and relieving the problem of OOS. However, this quick fix of urgent devanning results in the side effect of interruption to normal work flow which have the potential to delay normal scheduled devanning and causing more OOS. In addition, the double handing of shifting containers around on site leads to an increase in workload for the inwards team which could have the potential to increase stress and staff turnover to further delay the goods receipting time. So the side effects undermine the impact of the intervention and the OOS reverts back to its original condition after some delay.

Mental Models

Members of the supply chain team recognise that there is an issue that needs to be addressed immediately, but it is difficult to decide where to start. The supply planners were under pressure to meet customer orders and reduce OOS; therefore they instruct the inwards team for urgent devanning and busy fire fighting to catch up ensued whenever an OOS occurs.

The warehouse inwards team thinks if they just “kept their nose down” and follow the instructions from the head office by working harder and quicker they could help
relieve the OOS situation. But the harder they try, the bigger the problem become and the workload just keep increasing. One inwards team leader explained during a phone conversation:

“On top of further delays in receipting time, the cost associated with this mess is also increasing. Detention charges (similar to a library book overdue fine) are also increasing due to delay in returning the containers back to the freight forwarding companies. Storing a 20 ft refrigerated container could cost up to $500 extra per day!...We are going out of our way asking for special favours to arrange special container deliveries directly from the port of Auckland instead of going through the usual channel to shorten the lead time. But we are still behind. Do they know what they are doing?”

This scenario has an impact financially in terms of cost of goods. The management, seeing the decrease in goods receipting time was not performing efficiently, put more pressure on the inwards team. Special projects were also set up to investigate the possibilities of increasing the capacity by adding more people into the inwards team or having double shifts instead of just single 8 hour shift.

Figure 4 below shows some of the key underlying assumptions held by the staff. These are shown as ‘thought balloons’ which represent the mental models of the parties involved.
Scenario Two – Poor Case Fill Rate (CFR)

Following from scenario one, the OOS situation also directly impacted on case fill rate (CFR). This is called ‘service level’ in inventory management. The CFR target for FoodCom in year 2006 was set at 98%, which means 98% of the time when the customer orders a product, FoodCom will be able to fulfil the order, and fill the customer shelves with the desired products. An increase in OOS results in poor CFR which puts sales and customer services teams under undue pressure to meet sales targets to keep customers happy. During the monthly consensus meeting in June between supply chain, sales and finance, several events have been identified in relation to the CFR.
Events

- Pallet count (inventory) in warehouse was down by 2000 pallets
- CFR was performing poorly in 2006, category A was performing at an around 70% on average and a low of 57%
- Number of local truck deliveries increased by 15%
- Cost of failure increased substantially - in the second quarter airfreighting cost alone was over fifty thousand dollars.

Patterns of behavior

As the CFR deteriorates, FoodCom’s customers become more and more impatient and unhappy. The sales teams struggle to meet their target because some of the products are either OOS or pass the 4 months shelf life rule. The poor CFR also impacts on their relationship with the customers and some customers even threaten to de-list the particular poor performing product if the CFR do not improve.

In FoodCom, the transit time for sea freight imported goods from northern hemisphere is around 4 to 6 weeks, but due to the poor CFR rate, normally many airfreights are arranged to shorten the lead time in the hope to solve OOS issues and satisfy customer’s needs. While meeting customer’s needs are important, airfreight charges increase the cost of goods and the cost of failure. Moreover, when the product finally arrives in NZ, urgent local truck deliveries to the customer need to be arranged to further shorten the lead time. Some behavior over time graphs are shown in Figures 5 and 6 below to summarise the situation described:

Figure 5 -BOT for Scenario Two
Systemic Structure

The CLD shown in Figure 7 below has highlights the impact of CFR on some key financial KPIs such as cost of failure, distribution cost and profit. By doing more airfreights and truck deliveries instead of sea freighting, the product transit time is shortened in the hope to increase CFR and to satisfy the customers. But the transit time is shortened at the expense of cost. CFR is only relieved temporarily and customers are still frustrated which reflects in the low customer satisfactions.

Low customer satisfaction reinforces the communication breakdown between FoodCom and its customers. As the communication breakdown increases, FoodCom’s knowledge about their customer plan for promotional activities further decreases the CFR – hence was forming a reinforcing loop. This is expressed by one territory manager: “It would be nice if they (customers) have told us about what they were doing. But low CFR is frustrating our customers, and unhappy customers are less likely to have open conversations with us.” Moreover, sales team is finding it a lot harder to negotiate with customers in terms of shelf spacing. “Every time when we try to negotiate to increase ranging or shelf spacing, customers are hesitant to do so due to the low CFR. Some even ask us to get CFR back to target before going back to talk to them.”
Mental Models
This scenario represented a messy situation that could not be resolved with a quick fix of airfreight or truck deliveries. The tension between the teams overtime has also created some blaming culture with undesirable consequences for the organisation. Sales believe the planning team was not doing an adequate job to ensure there are enough inventories to meet the customer demand. Finance was also pointing at the planning team for the same reason which resulted in the increase in cost of failure and transport costs. The following quotes extracted from a telephone conference involving all key managers: sales, planning, finance and off-site customer services shed light on the stakeholders mental models:

“We are way off our target CFR of 98%, category A is currently averaging around 70%! I’m constantly getting pondered by unhappy customers about the miss orders and we got to do something!” said the customer services manager.

“What happened this quarter? Our airfreight cost has gone through the roof! In addition, our local delivery charges between North Island and South island have also increased due to more urgent truck deliveries instead of rail. What’s happening in the planning team?” said the financial controller Supply Chain.

“We have over sold in the last quarter and customer A was doing a big promotion on category A which we did not know about… they didn’t give us enough notice to respond to the change and depleted all of our south island stock. I understand our CFR looks horrible but I can only work on what information I have on hand...” said the supply planner for Category A.

“There is no such a thing as over sold - sales have basically under forecast and there is a communication breakdown.” said the demand planner for Category A.
In response, sales manager defended themselves: “What about the other categories that are not on promotion? The CFR for those are still off the target. It makes our job a lot harder out in the trade; some of the customers are even threatening to de-list our products if our CFR doesn’t improve soon... Our years of relationship with the customers have been significantly impaired by the poor CFR, planning is making our job very difficult.” “As for category A, we did not know about the promotion, customer A has just put the price of the whole range down to treat them as a lost leader. It will be nice if they have told us about what they were doing. But unhappy customers are less likely to have open conversations with us.”

“It’s just not good enough, you guys at the front line need to keep us informed, we can’t keep on doing this. We are spending thousands of dollars rushing around in the hope to raise our CFR, but our performance seems to be going down even more.” said the supply planner for Category A.

Following a recommendation to the supply chain manager, the SC team embarked a daily monitoring of the CFRs. This led to the discovery that a large proportion of poor performance was the result of customers ordering either deleted items or old product numbers (run-out lines). When a customer orders a deleted line or an incorrect old line number, it is also considered as a miss in the CFR report and hence exaggerating the true CFR figures. To resolve this requires customer services and sales teams to communicate and collaborate closely.

Validation of CLD Models

After initial data collection and one-on-one interviews, conceptual models qualitative system dynamics were constructed to develop a picture of the reality. Follow up meetings with participants were also conducted at this stage to clarify any ambiguous concepts and problem issues.

The links and relationships between the KPI's were presented visually through the use of CLDs and the four levels of thinking model. Once the scenarios and CLDs were validated and finalised, the next step was to bring the participants together to develop a common vision for taking significant actions on the issues investigated. This helped to uncover multiple mental models held by the participants.

Next section discusses group sessions where the participants were able to reflect on and discuss their existing processes and experiences to derive areas requiring change.

Group Discussion Sessions

Several group discussion sessions took place to enable the researcher to present findings and recommendations back to the organisation. In contrast to initial data collection interviews, where the participants focused on describing their experience of the issue and the context, this session was to ensure they understand the bigger picture and explore possible interventions. Group discussion sessions covered three areas:

- Introducing the system thinking concepts
- Discussion of Scenarios and CLDs identified
Recommendations for action (intervention strategies)

Overall, all the participants had a positive attitude towards system thinking concepts. This was demonstrated by their level of enthusiasm and engagement towards the scenario problems. Some participants were even interested in looking into further readings about system thinking which was a surprise.

By incorporating multiple stakeholders, participants’ understanding could be extended and different perspectives could be integrated into a holistic interpretation that satisfies the different participants. The group discussion happened in several sessions, each involving the participants that were relevant to the problem scenario.

The group discussions then moved on to discuss the recommendation and to give the participants a platform for formulating action plans and identifying priority areas for improvements. Original recommendations of the researcher were validated and if necessary modified with the rest of the participants in a collaborative approach.

Reflection

At the end of the group discussion session, participants were asked to reflect on what they had achieved and learnt. The reflections by participants were also taken during and after the implementation of proposed recommendation.

Participants were asked to evaluate the processes of this research. This information was valuable to assess the value of system dynamics in enhancing understanding of the trade-offs between performance measures and in supporting performance management decisions.

The focus group like discussion sessions turned out better than expected. Overall, the results confirmed that qualitative system dynamics modelling enhanced participant understanding of the causal relationship between KPIs. Moreover, the process clarified complex issues involving multiple objectives enabling decision makers to understand the strength and weaknesses of each approach to make an educated trade-off decision.

This approach illustrated that KPIs could exhibit contradictory behaviour between one another, typically across different functional teams, as was the case of an increase in sales which impacted the distribution cost negatively.

some extent demonstrating the Hawthorne effect. However, it is believed the scale and magnitude of the improvement cannot be simply explained by the extra time and resource devoted to performance measurement. The performance improvement observed during the course of this research is the largest increase in FoodCom’s performance as far as the staff can recall. This adds further confidence to the integrity of this finding.

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1 Hawthorne effect - an increase in worker productivity produced by the psychological stimulus of being singled out and made to feel important.
The debate between marketing and technical and production departments over strategic product ranging and factory complexity illustrates the trade-off concept perfectly. On one hand, product ranging is the main drive for sustainable growth and market share. On the other hand, the increase in factory complexity impacts short term financial results severely. The performance manager in the factory cynically referred to as “success is measured by how much we lost, because we are loosing money on every packet we sell.”

Nevertheless, the performance in cost of production improved as soon as the ‘unnecessary’ packet configurations were deleted. At the same time, the market share was unaffected as customers simply trade up or down to the next packet configuration available. This result surprised marketing and changed their stance towards the strategic ranging aspects.

**Team Learning and Commitment**

Decision making in FoodCom has always been complex and involves several strategic objectives that are sometimes contradictory. Each function team has different views of the situation and defines problems differently. The research showed that by sharing the underlying assumptions and mental models in the personal world, the participants were able to learn from each other and collaboratively construct a shared perspective in the social world. The shared perspective in the social world then can be derived into the technical world to modify system policies, to engage the behaviour of participants socially and hence change the mindset of people personally. As a result, conflicts can be minimized between different teams with different objectives and different KPIs.

The Causal Loop Diagram (CLD) illustrated several key advantages in investigating the interdependencies amongst KPIs. This provided a clear picture of different attributes of the problem variables and the interconnectedness amongst them. Cause and effect, time delays and feedback loops can be illustrated via CLDs and demonstrate the dynamic behaviour of the system. For example, in Scenario Two, the KPI case fill rate (CFR) is an important measure for customers. Lower values of CFR reflect a poor performance of meeting customer deliveries and hence reflecting a lower customer satisfaction. The CLD constructed showed how this KPI interacts with the other variables. An increase in delivery costs will lead to an increase in the CFR and conversely, an increase in communication breakdown resulting from a poor customer satisfaction which in turn decreases the CFR. Therefore the system thinking techniques, in particular developing CLDs enhanced participants understanding of the interdependencies through a holistic view of the system.

Overall, this research created a learning atmosphere to foster shared understanding, as a result, commitment and direction of the staff in the FoodCom changed. People no longer cling to “dearly held views” but instead are open to make compromises and to help out other colleagues in different teams. A classic example of this is demonstrated by Scenario Four – Sales trade spending vs. supply chain contract to clear.

“The key take-home for me from this discussion session will be regarding to understanding of ‘working as a whole’ concept, that write offs are not SC’s...
responsibility alone. Our sales trade spend budget and SC’s write off are really from the same bucket of funding.” said one key account manager.

Sales team started to change their mindset regarding the balance between trades spend funding and write off. Through discussion sessions, sales team demonstrated a sympathetic view towards supply chain by beginning to consider the funding as one pool of money.

Many participants described organisational learning was the most valuable payoff of this research. The benefits of system dynamics to explore inter-relationships of KPI for supporting decision making derived as much from the process as the outcomes of analysis. To staff members, in particular the research participants of FoodCom, this research study has influenced the way they think and act. This research is believed to have improved their shared understanding of the complex issues in particular the performance trade-offs of the organisation. The participants have also gained more appreciation of each other’s responsible areas and formed a stronger bond with each others. Some quotes identified from the discussion session have been listed below regarding to this area:

“I never thought about the problem this way, now I see! I guess I was a little selfish… I was probably the one that caused all the ciaos in supply chain. I shall arrange more meetings with supply chain to find out more about what they do.” Key account manager.

“It’s amazing how I have actually created these problems for myself!” supply planner

“I have got more exposure to other parts of the business especially marketing’s view on market share and product ranging. Being away from the head office makes it a lot harder to know what’s going on in other parts of the business. This session is beneficial, we should get more people involve in similar cross-functional discussions. It could add a lot of value.” Factory performance manager

**Group dynamics – Behavioural change**

As the researcher gained the trust of the participants and cross functional teams became more involved both in formal and social settings, closer goal alignment was achieved both vertically and horizontally.

Although the research disrupted some practices which have been institutionalised at FoodCom’s for a long time, it is expected that it will result in several positive influences on the participants and team dynamics. Two interrelated aspects arose from the action research cycles and were perceived to have contributed to the following learning and behavioral changes:

- Developing and sharing knowledge
- Valuing the big picture
Developing and sharing knowledge

"You cannot have a learning organisation without a shared vision...A shared vision provides a compass to keep learning on course when stress develops." — Peter Senge

From the beginning of this research, the behaviour of the participants notably changed gradually throughout the 18 months of this research. As a direct consequence of a shared vision, the level of communication between functional groups also increased. For example, supply chain department has now a stronger involvement with sales and marketing in product promotions. Sales team begun to take the proactive approach to check with SC and discuss possible stock level impacts before committing to special activities in the trade. Sales also developed a trade activity report so SC could have more visibility in trade activities and adjust demand and forecast accordingly.

By increasing the visibility of functional KPIs, some new opportunities has opened up for FoodCom. Rather than reinventing the wheel, the teams are now learning from each other, sharing information cross functionally using the same report. The development of a new monthly operations review (MOR) reports had a notable contribution to the increase in performance of some KPIs particularly in the last quarter of 2006.

The MOR report contains KPI figures which are used by all functions and each team is now more aware of what is going on in other areas of the business. For example, the report has enhanced communication between sales and demand planners and increased demand plan accuracy. This resulted in Case fill rate to increase to an average of 94% from around 70%. More importantly, the teams now understand how their KPIs could affect each others. The systems perspective and successful collaboration has proven to be gradually helping participants to aim towards feeling as one team with one common goal.

Valuing the big picture to prevent Sub-optimisation

This research has brought FoodCom one step further by exposing and changing their underlying mental models to reduce, if not eliminate, destructive competitions amongst functional teams.

A cross-functional view of performance measurement consolidating several functional aspects into one holistic picture tends to have greater effectiveness. At the beginning of the research, sales person A during one informal discussion viewed supply chain people as whistle blowers:

“SC team is the whistle blower, because they are usually the one that says NO to marketing’s new product launch ideas, NO to the promotion date that we have organised with the trade, they are the one that stop all the fun!”

But towards the end of the research, when asked to comment on the supply chain department again the same individual said:
“I never thought about an issue this way, now it seems so simple and it is all common sense. Why didn’t we look [at] the situation this way before? I now understand why they [supply chain team] are always challenging our ideas. To be honest we never actually think about whether it is cost effective or whether the inventory level is enough to go ahead with promotion...[before] it wasn’t really my problem. My only concern was how we can increase sales from particular activity. I missed the whole idea of the big picture and was only achieving local optimisation.”

The practice of personal reflection demonstrated a valuable and positive impact that this research had on staff attitudes. The combined power of action research and system thinking also contributed to this key success.

**Terminology and Gesture**

In addition to the change in mindset, the terminology/language used by the participants has also changed over the duration of the case study. As the participants became more familiar with the concepts of system thinking, they have started using its terminologies and phrases such as: ‘fire fighting; feedback; root cause; goes around in a loop; and the big picture.” Several of the participants also use hand gestures to draw a loop in air while explaining their interpretation of scenarios.

“I didn’t really see how I could help the SC department in terms of reducing bad goods and distribution cost, because after all, my job is demand planning and concentrating on the DPA and making sure that we meet our target of 75%. But now through identifying these causal relationships I understand! If the forecasted volume is too high, inventory goes through the roof; cost of working capital increases. Moreover, stocks become aged and will need to be written off when the expiry date hits us. Alternatively, if the forecasted volume is too conservative, we will be out of stock (started using his hand gesture to draw a loop in the air while explaining) which hits our CFR. In order to counter attack OOS, we need to arrange urgent devanning, urgent deliveries by truck to SI, which again increases more OOS. The loop just keeps on going!”

Research participants are starting to step away from the linear thinking and move towards closed loop thinking. Hence, recognising and capturing the dynamic cause and effects of a complex system.

- System thinking concepts and models can trigger behaviour change and enhance team learning in complex organisations

**Key Lessons Learnt**

The research aim was to use system thinking concepts and tools to investigate the interdependencies amongst KPIs and to understand the trade-off relationships between the indicators as well as the processes. The word that most appropriately describes the broad context for contemporary performance measurement is uncertainty (Milgate 2004). Businesses are constantly facing an uncertain dynamic world and trying to balance multiple stakeholders, multiple time horizons and multiple KPIs. Performance measurement and management need to focus on identifying the root causes of
performance problems and understanding the reasons for the change in performance. However, even when a comprehensive analysis of the problems is carried out, the identification of suitable corrective actions is still considered as difficult (Santos, Belton et al. 2002). While one KPI is achieving high levels of performance, it might be creating counterproductive behaviour on one or more other indicators. The success in one can only be obtained at the expense of another which suggests trade-offs between performance indicators are always part of the dynamic systems.

The outcomes of this research can be presented on two levels. First, introducing the concepts of system thinking and system dynamics modeling (in particularly the CLD) captured a holistic view of the KPI interdependencies. Understanding of the cause and effect relationships between indicators and general areas of performance was improved through the process of identifying events, patterns, systemic structure and mental models. This case study provided some evidence that the system dynamics approach had a substantial impact on improving FoodCom’s KPI performance. Most research participants agreed that there have been several improvements in the KPI results in the last quarter of 2006. By combining shared vision and the profound knowledge derived from personal mental models (identified from interviews) and collective team learning (through the discussion sessions), system thinking process enhanced the decision maker’s understanding and allow them to have the ability to make educated decisions. This research also raised an awareness of the dynamic status of the performance measurement phenomenon. Therefore, Senge’s fifth discipline on systems thinking is a pivotal ingredient of the success for this research.

Secondly, by conducting this research and giving the participants the opportunity to engage in the process of inquiry, they increased their knowledge of cross functional processes and changed their mindset and behaviour, showing more appreciation for the interests and concerns of other teams which were previously overlooked. Consolidating all aspects of performance measurement tends to have greater effectiveness. Thus, all employees will have the opportunity to contribute towards a share vision. Rigour can be achieved through balanced perspectives, ensuring the decision has been made by consensus, with everyone’s agreement and approval.

This research had a positive impact on FoodCom’s culture. It allowed the staff to engage and take ownership of the process and to achieve higher performance. Although the decision making process might have been considered as tedious and initially time consuming, the teams realised greater payoffs down the track. In general, people who are clearly informed are likely to be more motivated. This will have a flow on effect organisational behaviour and relationships.

**Research Contribution**

Although exploratory in nature, this study has important theoretical and practical implications:

From a theoretical perspective, this study firstly provides qualitative evidence that system dynamic approach can help the organisation to capture a holistic view of the systems and improve understanding of dynamic interdependencies and trade-offs amongst the performance indicators. Secondly, the use of four levels of system
Systems Thinking for Team and Organisational Learning

thinking model to explain and analyse the research problem had a significant contribution to this research. As the events were identified and behaviour over time graphs were constructed, significant insights into the underlying pattern of variables over an extended period were identified. Together with the causal loop diagrams, inter-linkages between cause and effect of the different KPI variables were mapped and subsequently integrated to demonstrate the systemic structure underlying performance measurement. The results, insights and proposed interventions were then communicated back to the stakeholders, which helped them to revise their mental model and facilitate learning in the organisation. This research represents a positive case for the combining action research, case study and soft system methodology.

From the managerial practice perspective, this study facilitates an open environment for cross functional communication and organisational learning. By constructing the CLD models, decision makers could enhance their understanding of how actions today can affect future performances. Therefore, decisions could be made proactively, enabling decision makers to initiate changes that are crucial to the survival of the organisation. The proactive rather than reactive management of performance was evident at the case study organisation.

From the above theoretical and practical implications, it is concluded that the use of system dynamics can helps develop insights for the relationships and the trade-offs between KPI. It also overcomes the sub-optimisation mindset and reduces the risk of making erroneous inferences of dynamic processes imbedded in complex systems.

FoodCom – 16 months on

We revisited the case company 16 months after the initial research and asked three questions as follow:

Q1: whether the collaboration between the teams has continued?

A: Yes, particularly in the Supply Chain team. There is a strong consensus amongst the entire SC division that communication and cross-functional collaboration had become the key area of focus for business success. The CEO commented that SC (and in particular the planners) is no longer just the service provider as they are now actively involved in the commercial part of the business (sales). The more SC understands the sales promotional plans, shelf strategy, pricing strategy...etc the more they can accommodate and even challenge the commercial part of the business.

Q2: whether the SC performance improvements have been sustained?

A: The main SC KPI results (DPA, CFR, Stock cover, bad goods, etc) have all shown consistent improvement. CFR, for example reached 97.5% in 2007. We believe that the improvement in results is in large part due to enhanced dialogue, awareness of potential KPI trade-offs and a deeper understanding of what other departments do and how their actions affect each other.

Q3: whether the employees have continued to utilise systems thinking concepts to maintain a culture of continuous improvement and learning?
Systems Thinking for Team and Organisational Learning

A: Since the introduction of Systems Thinking, FoodCom has initiated a “One Number principle” - a holistic view of business where cross functional stakeholders collaborate together and share responsibility to achieve a single company target. This is in sharp contrast to the previous mode of operations whereas sales had its own target, SC might forecast another number, and finance would budget for another figure resulting in endemic dysfunctional behavior. Although this is still work in progress, it is believed that the benefit from adopting a common performance measure is profound.

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A BUSINESS MODEL ARCHITECTURE: OBSERVATION PROBLEMS AND SOLUTIONS IN MODELLING BUSINESSES AND THEIR NETWORKS

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ABSTRACT
This study uses the Hierarchy Theory concepts of criteria, grain and extent, together with the concept of mutual value exchange, to construct an architectural model of the relationship between any two members of a network. These dyadic architectures can be assembled into a business model architecture that can be used to analyse the ‘health’ of the network, to support management or automation and to predict sustainability. This business model architecture theoretically develops the business model literature and the linked area of business process modelling and it produces a practical insight into the developing area of orchestrating networked businesses. An analysis of a network of organisations that produce Information, Advice and Guidance services for job seekers is used to illustrate the use of the model. The analysis produces theoretical implications about the relationship between modeller, model and subject as well as practical management implications for the manager as modeller and contrasting inter-organisational perspectives.

Keywords: business model architecture, Hierarchy Theory, specification and scalar emergence, perception, orchestrated business networks, careers guidance services.

INTRODUCTION
Models of businesses are an important subject for managers and researchers because they are a powerful tool for managing the entities that they model. For example business process models can be used to facilitate human understanding and communication; to support process improvement; to support process management; to automate process guidance; and to automate execution support (Curtis et al, 1992). Another model of a business is a business model. A recent study by Ostwalder et al reported a surge in occurrences of the term ‘business model’ in the academic journals of the Business Source Premier database (2005). In their study the first occurrences of the term appeared in 1957 and 1960 and its frequency remained in single digits until it rose sharply through the nineties and early part of the twenty first century. Business process models are not the same as business models since business models describe what value is generated and offered whereas business process models describe how this is done (Gordijn et al, 2000a). Models of businesses are an abstraction of the complex socio-technical systems that we call businesses. Well constructed business process models preserve the salient characteristics and inter-relationships of the business to be managed or studied by managers and researchers (Shaw et al, 2007a). The proper construction of a model reduces the complexity of the subject modelled from the boundedly rational modeller’s perspective. This is especially fortunate because the complexity of businesses has increased with the introduction of information and communications technologies (ICTs), outsourcing, globalisation and the associated rethinking of how firms can operate. Certainly ICTs enable individuals and firms to relate together and organise in more complex forms, like networked organisations which then presents more complex business modelling challenges.
A Business Model Architecture

The current ‘business model literature’ mostly lacks a theoretical basis (Porter, 2001; Hedman and Kalling, 2003) and uses many different definitions of the term (Hedman and Kalling, 2003; Pateli and Giaglis, 2004; Osterwalder et al, 2005). Pateli and Giaglis call for structuring and codification of the area and suggest a framework for analysing business models (2004). Also business model literature is concerned with firm-level analysis when managers are increasingly concerned with additional network levels such as supply chain management and B2B network orchestration (Shaw 2007b). The most sophisticated theoretical model in the recent business model literature is Hedman and Kalling’s (2003). They have assembled a set of theoretical constructs from different disciplines and used them as a basis for their component model of business models. This is a significant development because each component is theoretically supported by a robust foundation in the literature. However, their model does not theoretically justify the choice of components and their inter-relations are purely superficial links that do not theoretically unify the model.

Here I use the concept of value flow system (Shaw, 2007b) to construct a theoretically unified business model architecture of business models whose completeness is justified and whose inter-relations are fully explained. I also use Hiearchy Theory, Semiotics and Process Modelling concepts to theoretically explain the inter-relations of the model’s components. The architecture acts across many organisational levels which enables it to model the business models of networks of firms as well as the business models of firms themselves. This paper contributes to both a theoretical development of business modelling and the linked area of business process modelling and it produces a practical insight into the developing area of networked businesses. First, I summarise some of the opportunities for developing Hedman and Kalling’s model. Then I use concepts from the systems theoretical, theory building and business modelling literature to build such a business model architecture and then I describe my research approach. Then I introduce a case study of a specific network business and analyse it using the business model architecture that I have developed. Finally I discuss the novel analytical perspectives generated and the implications for managers and researchers.

LITERATURE REVIEW

Hedman and Kalling’s model of business models

Hedman and Kalling’s component model seeks to integrate diverse strategic perspectives such as resources, activities, firm structure, products and the market environment (2003). They try to do this by using theoretical perspectives from strategy research, business model research and e-business research to generate a set of components for a business model (see Figure 1). But they do not theoretically integrate these components. Each component is supported by theory but the arrangement and connection of the components is not. This has two implications; firstly, there is no theoretical justification for the completeness of the model, i.e. there may be other components that could be added and there could be other levels that contain components, e.g. components that model substitutes and compliments and sub-component constructs like those within the offering component (C3) and the resources component (C5). Secondly, the model does not describe how the components interrelate below a certain level of theoretical granularity. The relations between the components, what Hedman and Kalling call ‘causal inter-relations’ and ‘causalities’, are only described in terms of causes produced by one component and affects upon another component. The actual causal mechanism is not described or explained in the model and so it does not model how change is transmitted between the numbered components or why this is so.
Hedman and Kalling implicitly acknowledge the systemic nature of a business when they discuss the interconnectness of a business, e.g. improvements that do not actually save money, or increase profits, because excess staff are not made redundant or excess safety stock is not reduced (ibid). But their assembly of components does not explicitly model businesses as systems because they do not theoretically model the relationships between their model’s components. Business models that are based upon systems theoretical concepts need not suffer from this minimum theoretical granularity below which they cannot model. Also, business models that are based upon systems theoretical concepts can be proven as theoretically complete, i.e. the components that constitute the model can be theoretically justified, and so can the arrangement of the model’s components.

**Analysing the theory in Hedman and Kalling’s model**

Theories consist of “what” – the variables, constructs and concepts that describe the phenomenon of interest; “how” – the ways that they relate to each other; and “why” - the reasons for existence of the “what” and their relationships of “how” (Whetten, 1989; Sutton and Staw, 1995). Thus theories are two-level conceptual systems with the upper level describing the conceptual elements and how they interrelate and with the lower level describing why this is so. Conceptual models that are not ‘based’ upon theories do not contain lower level explanations for the upper level description. Also, this two-level system is recursive. The lower level “why” concepts are themselves explained by another, even lower, level of underlying “why” concepts until some level is reached that the theorist labels as axiomatic. This also applies to academic articles and other conceptual systems that are boundedly rational (Simon, 1997), i.e. they are limited in their conceptual modelling capacity by, for example, a maximum paper length. So called axiomatic concepts may actually be further decomposed in other academics papers or other disciplines. The components of Hedman and Kalling’s model (2003) are based upon axiomatic concepts from several disciplines and this separation in the reference disciplines has led to a lack of theoretical linking between in the components of their theory. As well as deep explanations of the relationships between its components the model also lacks a justification of completeness at the component level (Sutton and Staw, 1995). Hedman and Kalling do describe the numbered components (C) of their model (see Figure 1) as linking ‘causally’, i.e. the activities and organisation of a firm (C4) produce an offering (C3) which is bought by customers (C1) and competes with competitors (C2). But their model does not contain a theoretical explanation of this causal link.

As far as articulating theory in terms of its constructs, laws of interaction (relationships), state space and event space (Weber, 2003) Hedman and Kalling’s model lacks depth and detail. An example of this problem is where the model relates both customers (C1) and competition (C2) to offering (C3). These are relations between semantically different concepts. An offering is not dimensionally the same construct as either a customer or a competitor. Empirically we can see that there is some link between the model’s components
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but the model neither describes nor explains what it is. The model does not include substitutes so it is incomplete. Also the model does not explain why particular customers (C1) would be attracted to particular offerings (C3) only that offerings are made up of configurations of physical and service components and have prices and costs. The model does not explain why a particular offering (C3) would be produced by particular configurations of the activities and organisation of a firm (C4) only that they are organised in a value chain. The same limitations in explanation also apply to the other links that are denoted by block arrows in Figure 1, that link (C4) and (C5) and also (C5) and (C6). Thus the components of the model themselves each have lower theoretical levels that explain why the components are present in the model but not how the components inter-relate.

In summary, Hedman and Kalling’s model is the most theoretically sophisticated model that is available because of its theoretical basis in several reference disciplines but it has no underlying theoretical basis that (i) justifies the conceptual completeness, (ii) deeply explains its internal causal structure (iii) deeply explains its external connections to its environment, i.e. the structural relationship between a firm’s business model and the overall business model of the network that it functions within, and (iv) deeply explains how and why managers can develop it according to internal and external drivers. Next I develop an approach to modelling business models that is based upon Hierarchy Theory, Process Modelling Theory and Semiotics and I unify concepts from these disciplines with the concept of value.

A theoretical approach to modelling business models

In the business model literature value is commonly used to mean economic value and it is a core business modelling construct (Gordijn et al, 2000a; Gordijn et al, 2000b; Gordijn and Akkermans, 2001, Ostenwalder et al, 2005). The definition of economic value is how much a service is worth to someone else relative to other options (OED, 2008). This could be paraphrased as ‘value is defined by the observer’ and it allows me to introduce the concept of value perspective. Different actors make different valuations upon the same service because they have different uses for the same service, i.e. they have different service-needs (Shaw, 2007b). Service-needs are requirements generated by a downstream process for the output of an upstream process and for a good fit between the two processes the service and the service-need should be symmetrical. Using a systems theoretical perspective, the justification for this concept of ‘service symmetry’ is that process composition joins two lower level processes into a single meta-process, i.e. a single higher level process system. As a firm enacts business processes that are designed to realise its own business goals it produces service-needs. This also applies to products but in this paper we only refer to services. The value of a supplier’s service is produced by a customer’s processes (by a customer’s process needs) and not by a supplier’s processes. This is because value depends upon perspective and it is only as a component in the customer’s process that a supplier’s service can be valued. A supplier only directly values the payment it receives in return. Pateli and Gaglais mention values flows but do not define them except to say that they are usually difficult to express in monetary terms (2004). Parolini’s Value Net methodology is a strategic tool for competitive systems analysis but it does not use systems theoretical concepts that explore various inter-level phenomena (1999). Like Parolini, Shaw (2007b) conceptualises this system of interconnected services and service-needs as a value flow system. A value flow system is a model of a business that is based upon the concept of value exchange so a value flow system is a type of business model. In a value flow system the needs of the firm, its suppliers, customers and partners customers are inter-connected so as to mutually satisfy the different component firms in the network. A model of business models that describes such a value flow system (in terms of the multitude of services and service-needs of its component firms) has the power to explain why particular customers chose particular suppliers and particular services. This explanation would also be scalable
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from the sub-firm, to the firm and then the network level because its axiomatic concept is the service versus service-need fit which is empirically measurable and theoretically describable on all levels.

The concepts of services and service-need production via business processes produce a rich theoretical description of the relationship between a customer and a supplier because, using Hedman and Kalling’s components (2003), it links the business processes that a firm enacts in order to exist and persist (C4) to both the resources it consumes (C5) and its suppliers (C6), its offering (C3) and its customers (C1). A comparison of different suppliers’ offerings from the value perspective of a customer (C1) explains the recruitment of any particular customer just as, from another actor’s perspective, it explains the choice of any particular supplier (C6). A particular offering (C3) is produced by a particular configuration of the activities and organisation of a firm (C4). From the ‘downstream’ or ‘customer end’ perspective the configuration of input process is fully described by the service-needs of higher level, or ‘down stream’ processes. But from the perspective of a service supplier such higher level uses are unimaginable (unless they ask the customer) because they are emergent compositions of sub-processes. Emergence is a characteristic of systems and emergent phenomena are unknowable below the level that they emerge upon the sub-elements that are composed into higher level elements can be composed in too many different ways for anyone to guess at before their composition (Checkland, 1999, p. 314; Salthe, 1985, p. 100; Allen and Starr, 1982, p. 267; Ahl and Allen, 1996, p. 146).

A customer and a supplier is value exchange system that is mediated by business processes and instantiated by specific services that fit specific service-needs. The services-needs are dependent upon whoever generates them, i.e. they are observer-dependent, and they are generated by both customers and suppliers since such systems support a mutual exchange of value. Furthermore, any customer has many customers and suppliers themselves, as does any supplier. So a value exchange system is a complex system, i.e. the system does not necessarily have large numbers of elements but the elements have many possible inter-relationships (Anderson, 1999; Ahl and Allen, 1996; Allen and Starr, 1982). Observer-dependence causes a complex system to appear different to different observers because the different observers sense different relationships. In lay terms this is called having a different ‘perspective’ or ‘angle’, in business process modelling terms this is called ‘perspective’ (Curtis et al, 1992) and in General Systems terms it is called a different ‘level’ (Wilby, 1994; Ahl and Allen, 1996; Allen and Starr, 1982; Salthe, 1985). All these examples of a need for decomposition and simplification are caused by the bounded rationally of human observers who lack the capacity to mentally model the immense combinations of inter-relationships in a complex system at one time. So they break up the system along natural architectural lines or surfaces. Next I introduce some systems architectures from Hierarchy Theory, an approach for modelling complex systems (Wilby, 1994; Ahl and Allen, 1996; Allen and Starr, 1982; Salthe, 1985), that could be used to decompose complex value systems into models. Hierarchy Theory was developed in biology (e.g. Salthe, 1985, 1991), ecology (e.g. Allen and Starr, 1982) and single firm management systems (e.g. Simon, 1973).

Scalar hierarchies and the specification hierarchies

Two different architectures of system hierarchy are the scalar hierarchy and the specification hierarchy (Salthe, 1991). A scalar hierarchy is a hierarchy of levels. It is an artefact of observation derived from the natural structures that are present in a complex system like a firm or a network of firms. Entities upon different system levels are only loosely coupled, which allows them to be modelled by an observer as though they are upon several nearly-decomposable levels (Simon, 1969). Scalar hierarchies are asymmetrical in that higher levels tend to have lower coupling intensities and lower natural frequencies and lower levels
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have higher coupling intensities and higher natural frequencies (Wilby, 1994; Ahl and Allen, 1996; Allen and Starr, 1982; Salthe, 1985). Examples of scalar hierarchies are the organisational design of a firm from the CEO to the shop floor workers, [human-firm-network of firms], [leaf-branch-tree-forest] and [atom-cell-organ-human]. The levels are divided by natural regions of relatively low coupling intensity that appears to the observer-modeller as a system’s architecture. In scalar hierarchies higher levels filter and constrain the behaviours of lower levels. Specification hierarchies also have inter-level asymmetries but the inter-level transmission of phenomena is fundamental to their nature and it is not filtered as in scalar hierarchies. Levels in scalar hierarchies are separated by magnitudes of spatiotemporal scale but levels of specification hierarchies are separated by magnitudes of variety. Process stages are a specification hierarchy with each stage specifying a progression of transformations of inputs into outputs (Salthe, 1991). Table 1 compares properties of scalar and specification hierarchies.

The concept of specification hierarchy can easily be applied to modelling a business process because the process is modelled into stages that progressively specify a final output. In this terminology each stage is specified by a service-need that is required for the process to continue. However, the concept of scalar hierarchies can be applied to processes as well. A simple example is the collection of sub-process that produce the sub-assemblies that are aggregated into the final assembly of a machine. Potential confusion is avoided if we use the concept of observer or modeller. A specification hierarchy is modelled from the perspective of one process instance as it enacts. A scalar hierarchy is modelled from a perspective that can observe many instances, e.g. in a process model or a business model. Moving between scalar levels involves a change in frequency and moving between specification levels involves a movement through time in the instance of a process.

Table 1. Contrasting scalar and specification hierarchies (based upon Salthe, 1991).

<table>
<thead>
<tr>
<th>Scalar hierarchy ('levels')</th>
<th>Specification hierarchy ('process stages')</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger scale entities are <em>made up</em> of smaller scale processes. Level separation based upon degree of <em>aggregation</em></td>
<td>Sequence of development from general to specific, a <em>process</em> of refinement. Stage separation is based upon degree of <em>specification</em></td>
</tr>
<tr>
<td>Parts are nested within <em>emergent wholes</em>. Can be just organisationally nested, e.g. soldiers nested within a general’s command</td>
<td>Nested stages represent <em>emergent orders</em> of greater or lesser specification</td>
</tr>
<tr>
<td>Higher level variables appear as constants to lower levels. They constrain lower levels.</td>
<td>Higher levels are <em>more defined</em> than lower levels.</td>
</tr>
<tr>
<td>Synchronic – scalar systems simultaneously exist on all their levels in different spatial and frequency locations</td>
<td>Diachronic – specification systems exist over time</td>
</tr>
<tr>
<td>Three levelled. Level 0 constrained by level 1, driven by level -1. Mostly <em>non-transitive</em>. The boundaries between levels block inter-level signals. Signals <em>attenuate</em> with distance between levels. Signals are <em>two-way</em>.</td>
<td>Two levelled. Level 1 specified from level 0. Inter-level relations are <em>one-way</em> and <em>epigenetic</em> “one stage is required in order to get to the next”. Inter-level transmission is fundamental</td>
</tr>
</tbody>
</table>

Scalar and specification hierarchies are architectures for the system levels and process stages that in turn are the structure and behaviour of firms and networks of firms. Scalar
levels exist simultaneously in single instants and specification process stages occur serially through time. Scalar levels are differentiated by higher levels constraining and filtering the phenomena of lower levels. The stages of specification hierarchies are differentiated by process options such that the sum of a specification hierarchy is a full description of the transformation of raw material inputs into outputs. Both hierarchies exhibit emergence that does not allow higher level, or later stage, phenomena, to exist upon lower levels, or earlier stages. Higher scalar levels contain inter-relations of lower level elements that are separate on lower levels, e.g. a chamber of commerce will experience recessions but a single firm can only experience reduced sales because ‘recession’ is a concept that does not exist on the level of a single firm. Later specification stages contain the results of choices that were unforecastable in earlier stages because there were too many options, e.g. suppliers can never fully understand how customers use their products unless they ask.

As well as presenting architectures for breaking up complex systems so as to make managing them easier, these two hierarchies also represent opportunities for observation errors by the managers that use them to model problems. The modeller, i.e. the observer of a subject system, is also part of a wider observer-subject system. This is expanded by Semiotics, the Theory of Signs (Liu, 2000) to an observer-model-subject system (see Figure 2). In industry Business Process Management Systems are common examples of managers controlling real world system by using models (Shaw, 2007a, Shaw et al 2007, Shaw et al 2006). Including the modeller, or observer, allows the possibility that the process of observation may influence the modelling process. This is influence could come from several characteristics of the observer and the subject. Firstly, the observer and the subject may not be on the same scalar level and this applies to both temporal and spatial dimensions. Higher level concepts do not exist at lower levels because of scalar emergence, e.g. water molecules are not wet at the level of the molecule. When phenomena are transmitted from its originating scale to the human scale it is distorted. The scale of the observed phenomenon relative to the scale of the observer affects the observation process itself. Also, if the observer samples at the same scale as the observed phenomenon then the observer distorts the phenomenon because observer and subject become strongly coupled (Allen and Starr, 1982). An example of a same scale observer is a patient that is being observed by a psychiatrist that behaves differently than a patient on their own (ibid). A different scale observer example is a serial projection of discrete cinema projector images that are seen by a higher scale human as a single dynamic image (ibid). The lower frequency (higher level) human sampling frequency does not sense the gaps between the static film frames. This type of distortion can seriously affect experimental methodologies and is caused by reassembling several lower scale samples into a larger scale measurement (Wilby, 1994). The reassembly process itself may distort the phenomena samples. At the very least the observer’s presence does so, if only because it is the observer that reassembles the phenomena, and to the observers internal reassembly plan at that. Also, the observer has to choose the grain and extent of their observation. The grain of observation is the minimum perceivable fineness of distinctions and the extent of observation is the maximum perceivable size of distinctions (Allen et al, 1984). The phenomena to be observed must be larger than the grain of the observation and smaller than the extent of observation or else it will not be successfully captured. This is the same as in experimental sample design and case study choice. In spatial scales an example of an unsuccessful choice of grain and extent is a fishing net that is too small for the big fish or one that has holes too large to catch small fish in. In temporal scales a example is the choice of frame frequency of old cowboy films that seemed to show the wagon wheels turning backwards because the time grain of the camera frames is not frequent enough. An error in the choice of extent here would be that the camera operator shoots the film before or after the wagon goes past the camera.
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Secondly, in addition to scalar observation errors there are also potential specification observation errors due to specification emergence. Specification emergence is different to scalar emergence. Again higher level concepts do not exist at lower levels but in this case higher levels are later process stages and higher level concepts are option choices that are too varied to be forecast, e.g. the unforeseen uses of software by users that partly justifies beta testing in software development. The other part of the justification is the complexity of modern software itself.

Using a scalar hierarchy perspective, different firms exist on different levels of a network and different business phenomena exist at different levels, e.g. an orchestrator like Manchester United Football Club is concerned with emergent phenomena that do not exist at the level of a single partner in its network (Shaw 2007b). Using a specification hierarchy perspective, different firms may look for different phenomena because they have different histories. So they have different business processes and therefore different service-needs. Different service-needs mean that they value different services so they look for different phenomena and also measure phenomena in different ways. This means that observers will have different observation criteria, i.e. different firms with different markets, missions or strategic goals will have different interests. Difference observation criteria can introduce potential observation errors, e.g. two firms may fulfil slightly different service-needs which may suit subtly different types of customers. This is the justification for market segmentation. I have used the above concepts of criteria, grain and extent together with scalar and specification hierarchies and the notion of mutual value exchange in a value system to construct an architecture of the relationship between two value system elements (see Figure 2). Figure 2 shows a theoretical basis for the architecture of the value flows that join the members of a value flow system. The architecture can be used to analyse their ‘health’, to support management or automation and to predict sustainability.

In Figure 2 the observer or modeller is shown by an eye in the top and the bottom thirds. Phenomena from each subject (i.e. the affect of the service) are shown being transmitted from each subject (the customer and the supplier) to each observer because this is a model of mutual value exchange (e.g. a service for a payment) and value is only measured by the receiver. In a sense the supplier is the customer’s customer for the payment and the reverse is true as well. Each service phenomenon is received and measured via each observer’s observation framework. The observation framework is a model of what is needed by observers to meet their goals and it is designed according to each observer’s observational design decisions about grain, extent and criteria. Using the three semiotic dimensions: (i) the semantic view is the link between the model and the subject that is modelled, (ii) the pragmatic view is the link between the observer and the model and (iii) the syntactic view is architecture of the model (Liu, 2000). The middle of Figure 2 represents the span of the different structural levels or process stages that separate the observers and the subjects. Figure 2 can be used to model of the relationships between all elements of the value system.

Figure 2: Architecture of the relationship between two value flow system elements.
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on the network level, the firm level and lower levels down to the human level. Such a model of the value flows between network members enables the modeller to assess how sustainable the business model of the network or any firm in the network is. This architecture can be used to check for errors in service production and reception as well as unmet service-needs and unrequired services.

RESEARCH METHOD

This investigation includes a multi-actor as well as a multi-level study so it takes an interpretative stance, because of the subjective nature of human interaction. It iterates around a hermeneutic circle, between network and organisational level perspectives so as to consider an interdependent whole (Klein and Myers, 1999). The novelty of using hierarchy theoretical concepts in the inter-firm network domain points to a qualitative approach because the investigation is concerned with initial questions of ‘how’ and ‘why’ rather than of ‘how many’. In in seeking to answer ‘how’ and ‘why’-type questions, following Yin’s recommendations (2003), the investigation uses a case study approach because it is concerned with contemporary phenomena, which I have no control over, of business relationships between many different firms from many different sectors. The use of a single case has external validity implications, that is, generalisation implications (Lee, 1989), but a single case is justified at the outset of theory generation (Benbasat et al., 1987) and although it may limit statistical generalisation is does not degrade analytic or theoretical generalisation (Robson, 2002). This is consistent with the theory building objectives of this study. I am concerned with dynamic phenomena so I have used different data collection methods and different sources (Eisenhardt, 1989). Over a 16 month period interviews ranged from 15-min informal conversations to semi-structured meetings and recorded and transcribed interviews. Interviews were with sub-contractors as well as a nextstep organisations’ senior managers and the top team including the contracts manager, who manages the sub-contractors and organises sub-contractor networking meetings. Overall, I used triangulation to converge evidence, analysis and synthesis upon the same phenomena at the dyadic relationship level and at the network level. A very good relationship with the case participants also helped to reduce validity reactivity and increase trust as well as disclosure. Data sources included meeting notes, meeting transcriptions, telephone conversations, archival data, organisation reports and the website content of the different organisations involved.

NETWORK ANALYSIS USING A VALUE FLOW APPROACH

The case study network is a nextstep network which will be referred to as ‘NS’. NS is one of 47 English not-for-profit organisations that are each called a ‘nextstep’ and that are contracted to provide the nextstep service in their local county. The nextstep service helps adults to develop to meet labour market needs via courses or training (NS Website, 2007). In 2000 Information, Advice and Guidance (IAG) partnerships were set up in England as part of the Government’s lifelong learning agenda and from 2005 they were branded as ‘nextstep’ (NS Website, 2007, NS Contract Manager, 2007). NS holds several contracts and only one is the nextstep contract. The nextstep contract obliges NS to provide an information service about skills, learning and work to all adults aged 20 and above; and a more targeted advice service for those without a Level 2 qualification (i.e. five GCSEs at grades A* to C or the equivalent). Information, Advice and Guidance are three progressively more intense and specific interactions with clients from general information to advice in answer to questions and then in-depth guidance via an individual meeting (LSC, 2007c). The service that a client receives from the NS network could include, for example, advice on
preparing a CV, interview skills and services available during redundacy. NS contract holders also help adults with English as a second language and those with learning difficulties or disabilities. The contracts are funded by a budget controlled by the Learning and Skills Council (LSC) and are limited to England. Each contract is awarded by the head office of LSC and it is operationally managed by a contract mananger from the local LSC office (nextstep stakeholder, 2008). NS consists of a management team, careers advisers, administrators, trainers and a marketing officer (NS overall manager, 2007).

The NS network is shown in Figure 3. The IAG service of the NS network is generally produced by NS’ sub-contractors and consumed by clients although some nextstep organisations service clients directly as well as indirectly via sub-contractors. The IAG service guides the client through the process of moving from one careers stage to another. This can be as early as the initial occurrence of the idea for a change of job or career to as late as actually getting a new job. NS’ network of sub-contractors guides clients through the initial search for information, the consideration of what paths to take and then they give directions and recommendations for courses or other requirements that will help the client on this journey. The funding requirements are that the client is 20 or above, below a certain level of qualification and living in the NS’ county. NS and its sub-contractors also work with other employment, education, training, voluntary, trades union and community organisations (nextstep stakeholder, 2008). NS uses the nextstep contract as a core for other services which it funds via other contracts from different IAG funding organisations.

The value flow system for the NS’ nextstep network is shown in Figure 4. The LSC contributes funding for the nextstep core contract and needs data on the number of clients helped and how they have been helped. NS sub-contractors provide IAG to clients and give operational and results data to NS in return; they need developmental support from NS in the areas of training to improve their service and reporting capabilities in addition to their inter sub-contractor communications and coordination. They also receive nextstep funding via NS. NS sub-contractors also collaborate with each other and non-NS clients to provide services that seek to realise their organisational objectives. NS needs the sub-contractors’ data that describes how they have helped clients so that it can aggregate it and pass it onto the LSC in return for funding. In return NS channels funding to the sub-contractors and helps their organisational development. Other funders also provide funding to NS and the sub-contractor organisations for other IAG related services to clients in the county that are not covered by the nextstep core contract. Other funders also require some form of feedback of performance data as evidence of the successful use of this funding.

![Figure 3: Elements of the NS network focusing upon the NS ‘core’ contract.](image-url)
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![Diagram of a business model architecture](image)

**Figure 4: Value flow system of a nextstep network.**

**Value flow analysis of NS’ nextstep network using the value flow architecture**

Next I will illustrate how a business can be modelled in a way that improves on Hedman and Kalling’s approach (2003) by analysing the value flow system of the NS network in Figure 4 using the value flow architecture in Figure 2. I have divided my analysis into value flows across the network boundary (dashed line) and internal value flows. Due to space constraints I will focus upon the relationships, for value flows across the network boundary, between (i) the LSC and NS and (ii) NS sub-contractors and the clients. For internal value flows I will focus upon the relationships between NS and the sub-contractors. In keeping with the value flow architecture in Figure 2 I will highlight examples of ‘good’ and ‘bad’ fit from choices of observational grain, extent and criteria due to level differences in scalar and specification hierarchies. Examples will come from either end of the relationships.

- the relationship between the LSC and NS

From the LSC’s perspective it funds the network’s nextstep service to clients and requires data on the consumption and effects of that service. From NS’ perspective the nextstep may only be one of several contracted services that it delivers and all funders require different results data. For example, some want to know the clients’ National Insurance numbers, some require follow up interviews after different time periods to check the results of the service and some just require a measurement of client satisfaction. The LSC funds on an annual cycle but NS’s work is continuous. For example, in a journey to employment a client may need several IAG interventions but the nextstep contract only pays for one. However, there is no LSC-level ‘memory’ between yearly cycles so clients can benefit form the nextstep service more than once as long as the interventions are in different financial years. This is particularly relevant for client stages that are on a frequency like 12 month long training courses.

- the relationship between NS sub-contractors and clients

The sub-contractors are funded according to the county geographical boundaries of the nextstep network that they are in and the educational level boundaries of the client. This may be irrelevant to a client who hears of an interesting course from a friend who lives nearby but in another county or is slightly less qualified. The different funding sources that some sub-contractors (and on another level NS) use provides diversity advantages in addition to extra money. Funding is usually designed for specific services so contracting from several funding sources allows sub-contractors to bundle several services together which from the client’s perspective is perceived as help through subsequent stages rather than just one. From the client’s perspective an IAG advice meeting is needed before and after each stage. For example before the client goes on a CV writing course the client needs help in deciding that this is the right course and after the course the client needs help in choosing the next
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stage. NS sub-contractors also produce services for non-NS clients that are themed around their own particular charitable or organisational goals.

- the relationship between NS and sub-contractors

NS passes on reporting requirements from the LSC level to its sub-contractors e.g. NS requires its sub-contractors to give it data on serviced clients that it aggregates and processes for the LSC but this is only one type of data for one of several organisations that the sub-contractors consume funding from. Generally NS acts as a filter and translator between the LSC and its sub-contractors but for one new funding contract in a single county the LSC wanted to directly communicate with the sub-contractor’s level. The LSC asked the counties NS to invite all its sub-contractors to a meeting but other than that it did not use the NS’ experience of sub-contractor management to initiate this new project and this had some negative consequences. When it presented the new funding opportunity to the sub-contractors it presented the news very simplistically and some sub-contractors felt patronized. NS had a much better knowledge of the sub-contractors’ understanding on the issues that were containing in this new project and would have communicated accordingly. The sub-contractors had very different degrees of understanding of the new projects’ context and goals. Some were more experienced in this area than NS or any other organization at the presentation. Also, the LSC was not ready for the questions that this presentation stimulated from the sub-contractors about how they would be paid and so it was not ready to answer them. Furthermore the LSC in this example did not consult the NS about publicity material and produced a leaflet for clients with NS’ address on it. This address was useless to clients because they would consume this new service at the sub-contractors’ offices rather than the NS office. Finally, the LSC required that all the sub-contractors attend but for some their presence was irrelevant because their service and the new project were unrelated. These sub-contractors found this direct intervention by the LSC particularly irritating because for them the cost of transport and the time allocated to the event was significant.

Table 2: Two contrasting perspectives on grain, extent and criteria for each of the different relationships within the nextstep network.

<table>
<thead>
<tr>
<th>LSC (nextstep funder role)</th>
<th>Nextstep (NS)</th>
<th>Sub-contractor</th>
<th>Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain: LSC have local contract managers that connect the LSC to each nextstep. Extent: the LSC manages all the nextsteps. Criteria: LSC is interested in an organization that can manage and develop a network of sub-contractors on its behalf.</td>
<td>Grain: The presentation did not need to differentiate between sub-contractors. Extent: LSC’s presentation reached all the sub-contractors. Criteria: The presentation was meant to introduce the new funding project.</td>
<td>Grain: Client IAG and follow-up data is secured. Extent: All leaflets had addresses [sc]. As many clients are given IAG as is possible within the funding. Criteria: LSC is interested in a set of IAG sessions and their affect on a client population.</td>
<td></td>
</tr>
<tr>
<td>Grain: NS connects to local LSC contract managers. Extent:</td>
<td>Grain: NS manages sub-contractors</td>
<td>Grain: sub-contractors pass data</td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>(NS)</th>
<th>LSC holds client data for 1 year. <em>Criteria:</em> NS is interested in developing sub-contractors ability to guide clients through a whole job-finding process that may take years.</th>
<th>individually &amp; together. <em>Extent:</em> NS manages all sub-contractors. <em>Criteria:</em> Different strengths of sub-contractors can be combined to meet a full portfolio of geographical, client-type and stage needs.</th>
<th>from client meetings to NS. <em>Extent:</em> all client meetings generate data. <em>Criteria:</em> NS is interested in fulfilling a ‘mosaic’ of contracts to generally help clients in the area.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-contractor</strong></td>
<td><em>Grain:</em> LSC’s presentation did not differentiate between sub-contractors’ expertise &amp; data needs. <em>Extent:</em> Some sub-contractors did not need to be there. <em>Criteria:</em> sub-contractors have organisational missions that focus on themes such as race, location and specific sets of client needs but the LSC did not differentiate between them and invited irrelevant sub-contractors.</td>
<td><em>Grain:</em> NS manages sub-contractors individually &amp; together. <em>Extent:</em> NS manages all sub-contractors. <em>Criteria:</em> Sub-contractors get funding, developmental help and better contact with other sub-contractors.</td>
<td><em>Grain:</em> Clients have individual IAG meetings. <em>Extent:</em> Number of clients seen limited by funding. <em>Criteria:</em> Sub-contractors offer specific services due to their founding objectives, capabilities and location(s).</td>
</tr>
<tr>
<td><strong>From Client</strong></td>
<td><em>Grain:</em> leaflets produced by the LSC did not differentiate between different meeting locations that a client would use. <em>Extent:</em> The LSC funds just one IAG session but a client needs several of them to serially connect stages in their job-finding process. <em>Criteria:</em> A client uses IAG meetings to serially connect stages in their job-finding process.</td>
<td><em>Grain:</em> A client’s individual IAG meeting is funded. <em>Extent:</em> A client is seen (if there is funding left). <em>Criteria:</em> A client uses IAG meetings to serially connect stages in their job-finding process.</td>
<td><em>Grain:</em> A client has an individual IAG meeting with a sub-contractor and some other form of support. <em>Extent:</em> client is seen if there is funding left. <em>Criteria:</em> A client chooses a specific sub-contractor due to their specific needs, location or ethnicity.</td>
</tr>
</tbody>
</table>

Table 2 examines the contrasting perspectives of the different relationships between LSC, NS, sub-contractors and clients using three examples: (a) the presentation of the introduction of a new funded service (that is in addition to the nextstep contract) directly from LSC to sub-contractors, (b) the clients’ IAG meetings and the data that they generate and (c) the production and consumption of the nextstep service in general. (b) is a specific part of (c) and (a) is new service of the logical type as (c). Each cell examines a dyadic relationship with the column heading member from the perspective of the row heading member, e.g. the top right cell (client, LSC) is the LSC’s perspective of its relationship with the client group. The contrast between the perspectives of two parties in each relationship can be seen by comparing diagonally opposite cells.
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DISCUSSION

In my analysis the different perspectives are most obviously apparent in the greatly contrasting criteria, e.g. a client is interested in how any one relationship or meeting helps them to progress along a process that ends with a new job. Whereas the other members seem to view the clients as one group but to differing levels of granularity. The sub-contractor’s perspective comes from its own developmental process and organisational goals, as do the other member’s own perspectives, of themselves, and these also contrast with members on higher and lower scalar levels. The perspectives of the two sides of each relationship can also contrast in terms of grain and extent. In some relationships there is a fit between grain, e.g. when local LSC presence fits each local NS or when sub-contractors have individual IAG meetings with clients, but sometimes there is a contrast between the granularity of how one partner views the other, e.g. the LSC may not differentiate between sub-contractors or clients. Similarities and contrasts also exist for the extent of a dyadic relationship as viewed from the two partners. For example, the extent of funding may be problematic for a client who cannot be seen because the funding has been consumed. But a sub-contractor, especially one who’s capacity to produce services is full, may perceive this funding extent as normal or even as planned.

In a progression from high level to low level, the LSC differentiates between clients the least, then NS sees more differences between clients, e.g. an IAG meeting may point to accessing another sub-contractor’s services, and finally the sub-contractor actually meets them individually. However, only the client can perceive its route to a new job as a process. The other members just experience greater or lesser abstractions of collections of stages in clients’ processes. The strongest contrast between the two ends of this dyadic system is between the processual perspective of the specification hierarchy that is used by clients consuming services and the structural perspective used by service producers. For example, clients are concerned with their serial progress towards their new career and job but the sub-contractors view them as a population of IAG and training events and they very different organisational goals. Similarly the sub-contractors’ development and goal attainment is their reason for membership of the network but NS is concerned with fulfilment of the nextstep and other contracts and the LSC is concerned with improving the skills of England’s workforce.

The sub-contractor’s perspective of its own service-needs is specificational as it comes from its own developmental process and organisational goals and this also applies to the other members. Also members’ perspectives of the services produced by other members are specificational for the same reason. But a member’s perspective of the organisational arrangement of other members is scalar because they are perceived to exist upon higher and lower hierarchical levels. This duality of perception, where services and service-needs that the member directly experiences are specificational and indirect experiences are scalar, can be explained by the concept of experience. The indirect experiences are actually models and external models are arranged in a scalar structure. Where as internal models of one’s own process through time are arranged in a specification structure. Only service-needs and service are ‘directly’ experienced and so not actually modelled. With more intervening scalar organisational levels between the observer and the subject, e.g. between the LSC and a client, then the more scalar abstraction occurs. This is scalar emergence. With more intervening specification levels between the observer and the subject, e.g. between a client at the start of a career change process and the eventual new job, then the more alternative routes there are. This choice of routes is a specification emergence. Looking in the opposite temporal direction of this personal internal process model, an increase in specification levels between the observer and the subject, e.g. when reviewing a memory, would not necessarily be a barrier to recollection because specification emergence only acts in the direction of causality.
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CONCLUSIONS AND IMPLICATIONS

The customer and the supplier in each relationship and each transaction are both the observer and the subject of each other. They each have other customers and other suppliers. Appropriate choices of grain and extent are needed when the observer and the subject are on different value flow system levels. From a scalar level perspective this is means that higher level service producers should differentiate between the requirements of lower level service consumers, e.g. LSC to sub-contractors, and, in terms of grain and extent, they should include all appropriate potential customers. Also, lower level service producers should remove irrelevant details from submissions to higher level service consumers, e.g. sub-contractors to NS. From a specification stage perspective, this explains why service producers can never completely forecast all the uses of a service even when the service consumer is on a lower organisational level of their own firm. Appropriate choices of criteria are needed in order to fit each producer’s service with consumer’s specific service-need. A scalar model of the customer’s place in the network can be used to organise which potential consumers to forecast a service-need for. The service-need can then be used to forecast a service design using a specification model. The scalar model focuses managers on specific potential consumers and the specification model then enables them to forecast specific needs.

My architecture for modelling the business models (Figure 2), which is operationalised in Table 2, can be used to model the value flow system of a network. The model describes the sum of the service-needs and services in the network and enables the modeller to check for fit at different levels and stages and according to different criteria. If the services and service-needs of the different members at all levels and stages of a subject network fit then the network has a healthy business model. If some particular service-needs are not met by current services then the model has highlighted changes that are required. If some particular services are not consumed by current service-needs then again the model has highlighted changes that are required. Networks of firms and their internal and external customers are assemblies of human goals, values and the requirements that they generate as time passes and people move along their personal journeys. These requirements are dynamic and are emergent when people inter-relate in organisations on different scales. The sustainability of any firm or network or organisation depends upon the success of that organisational design in the mutual satisfaction of the interrelated people. This model enables the organisational design of services that should satisfy service-needs, via business processes, to be checked at different scales and frequencies. The ability to check such systems of mutual satisfaction is based upon the modelling of the values of the people involved at different scales and frequencies.

I have developed an architecture for modelling the business models of firms and networks of firms that is based upon the notions of the observer-model-subject system, the value system and two different system architectures. This model explains why particular customers choose particular suppliers and particular services. The model uses the concept of value and it has an underlying theoretical basis from Hierarchy Theory, Process Modelling Theory and Semiotics that (i) justifies its conceptual completeness, (ii) explains its internal causal structure (iii) explains its external connections to its environment, i.e. the structural relationship between a firm’s business model and the overall business model of the network that it functions within, and (iv) explains how and why managers can develop it according to internal and external drivers.

By introducing the concepts of scalar hierarchy, specification hierarchy and value to this domain I am able to describe and explain why any particular configuration of a process occurs and how it occurs. Also the concepts of scale and specification hierarchies allow this
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theoretical model to be used at any level from the level of one business process to the level of an inter-firm network. One limitation of this study is that clients do not pay for these services and this points to further research on networks whose services consumers also fund the service. Another limitation is that it is a single case and single sector study.

REFERENCES

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**SOCIAL RESPONSIBILITY – AN INNOVATION OF ETHIC TOWARD REQUISITE HOLISM AS A BASIS FOR HUMANS TO MAKE A DIFFERENCE IN AFFLUENCE**

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**Abstract:** Economic laws from Adam Smith’s times no longer work for the most advanced parts of the contemporary world. An innovation of values/culture/ethnic/norms must be introduced to make the difference. Global ethic is suggested. So is happiness as criterion of success. Social responsibility matters for humankind to continue its evolution beyond the phase 4 foreseen by Porter - affluence. In affluence needs, perhaps even wants, are scarce rather than resources. This kills the ambition to create in order to have. Happiness can result from the ambition to create and be beneficial beyond having. Thus, maybe, a new concept is showing up, in which innovativeness is no longer a technological or short-term profit-oriented one only, but using / developing human creativity, co-operation capacity, and professionalism as a source of happiness reaching beyond the material content to help life make sense. Official action to promote social responsibility aimed at requisite holism of humans is suggested beyond publishing documents.

**Key words:** creativity, Dialectical Systems Thinking, economics, happiness, holism, innovation, social responsibility

**0. The Selected Problem and Viewpoint of Consideration of it here**

According to official data, 20% of humankind – the so called West and Japan and Pacific Rim Tigers – enjoy results of the end of monopolies of 1870s much more than the other 80%. They are much richer because they innovate much more, but they are not holistic enough to avoid the danger of blind alley. The current crisis of the most advanced parts of the world seems to require innovation of the concept of innovation of so far. So does poverty around the world.

**1. Huge Social Differences – Source of the Need for Global/Planetary Ethic**

Poverty is the biggest challenge to the global harmony – a conclusion of sociologists in an international conference reads (Marcuello Servos, 2006, 10). Complementary to it is data that the distribution of global richness has changed very much since times of Adam Smith, when the modern economic theory has begun its creation: then the span of richness between the big areas of civilization on the planet Earth was less than 2:1, now it is 74:1 at least (Bourg, interviewed by Sciami, 2007, 16). The Swiss philosopher Bourg estimates that our civilization is ruining itself, because it decided to consider no limitations in no areas; this is why Bourg speaks for planetary ethic.
Namely, inequalities ran out of any proportions, and cause hyper-terrorism against the privileged ones. In addition, there is a great challenge to modernize the relation of humans to their natural environment in the direction to the global ethic. This might be called a way of application of the requisite holism (RH – see Figure 1 later) by systemic thinking, decision making and action.

2. Advancement Leading to Poverty

The too one-sided human decisions in the recent centuries caused the oversight that the technological advancement has along with beneficial also detrimental consequences. One-sided assessments call the latter side-effects, but they are often essential, in the long term, at least, such as unexpected illnesses etc. due to chemicals etc. considered beneficial.

Data says that the growth of the richness of the Western world has been much bigger in book-keeping than in long-term real economic terms – the West only postpones rather than covers cost of preservation of its and our natural environment (Bo_i_nik, 2007). The economic consequences of such short-sighted abuse of the law of external economics are estimated to be enormous (Stern, interviewed by Stein, 2007, 14-15): if humankind does not tackle climate changes very quickly and radically, they may cause humankind’s cost as high as 5,500 (five thousand five hundred) billion Euros, which reaches beyond the cost of both World Wars combined; with no measures diminishing hot-bed gasses the world-wide GDP will fall for 5%, perhaps even for 20%.

The latter may be close to the entire sum of personal incomes of all in the current world. RH is unavoidable.

The huge differences and poverty that are expressed in the book-keeping data, hence, result from poverty in the human capacity to monitor reality, think, decide, and act with RH. They result from one-sidedness causing a too narrow view and resulting assessment what is essential in the current conditions.

All specialized knowledge is both narrow and beneficial, unavoidably, but none is either self-sufficient or sufficient (Metcalf, 2008; Mulej, 1974, 1975, 1979). Democracy supports holism, but it is not RH, if it is only political without inclusion of all other human relations too. It is not real, if its practice means only an untouchable out-voting to the benefit/victory of the one-sided opinions of the power-holders instead of an equal-footed consideration of proofs and arguments from different viewpoints that are rather complementary than harmonious with their differences.

3. Ethic of Interdependence, Poverty, Economic Growth, Affluence, and RH by Social Responsibility

In preparation, passing, and realizing of decisions one succeeds, it one has attained the requisite holism. This does not depend on knowledge alone, even less so on a single profession, but an equal importance belongs to values, because they direct the application of knowledge. The RH of values of specialists who need each other is expressed in their ethic of interdependence (Mulej, Kajzer, 1998a, b). It expresses the feeling that specialists complete each other up with their differences in order to make the RH and therefore success attainable. Due to these differences, clear boundaries and isomorphisms are not enough: viewing the world ‘through the eyes of the others extends vision’ is needed (Churchman, 1993, quoted by Lopez Garza, 2008) toward the ‘dialectical systems approach (Mulej, 1974, 1975, 1979, etc.) and resulting RH (Mulej, Kajzer, 1998a, b).
Discussion on problems of social differences, affluence, poverty, and economic growth in terms of RH, makes us think of ways toward solutions. This brings us to the concept of social responsibility (SR) and to the European Union’s (EU’s) concepts about it.

EU is trying to become a sustainable and knowledge-based society; the concept includes for sure the SR. In its document (EU, 2001), EU defines SR as the integration of the care for society and environment in the daily business of enterprises and their relations with stake-holders, on a voluntary basis. This is in line with EU’s strategy of sustainable development that EU has passed in 2001 as well. Its messages include the crucial statement that in a longer run the economic growth, social cohesion, and environmental protection complete each other up and support each other. It stresses too, that SR-behavior reaches beyond matching the legal obligations, hence it reflects organizations’ additional efforts to meet expectations of numerous/all stake-holders. EU passed also several other documents that support development of SR (EU, 2000b; EU, 2006). They only partially cover the real contemporary needs – the creativity-based society is replacing the knowledge-based one that has replaced the routine based one (Chesbrough, 2003), and the concept of sustainable future needs to replace the concept of sustainable development (E_imovi_ et al, 2008), for humankind to survive.

EU defined for the period until 2010 ‘A European Roadmap’, stressing the sustainable and competitive enterprise, which considers both the short-term and long-term creation of values (Knez-Riedl, 2007b). The corporate SR can fortify the competitive position of single enterprises as well as local and regional communities, countries and EU (Knez Riedl, 2007a). We prefer no limitation of SR to companies: they act along with influential humans’ decisions.

In Slovenia, too, many activities concerning SR took place in recent years, mostly in civil society. Various professional organizations and institutions include in their work programs SR contents (www.irdo.si), professionals take additional training (project CSR – Code To Smart Reality was co-financed by EU in 2006-2007), increasingly B.A., M.A., and doctoral theses about SR are created (www.nfrcsr.org). A strategy might result or be needed.

4. **Strategy of Promotion of Social Responsibility (SR)**

SR is a demanding concept of promotion of a specific case of RH having to do with the human approach to other people and nature. For success many influential people should practice RH via SR. Work of a few individuals – professionals is not enough, a general social support based on a clear strategy is needed, e.g. on the national level.

SR Mission should be to promote global ethics in order to help humankind, including one-self, survive by doing good to all stakeholders (based on RH) rather than evil (based on one-sidedness) beyond the official legal obligation.

A working group with an interdisciplinary composition should prepare a draft strategy, and later on special Agency for Promotion of SR might have to be established, e.g. in Slovenia and in EU etc. Its tasks should include co-ordination of country-wide or EU-wide SR-related activities in co-operation with several professionals and institutions. Thus, the following goals should/could be met:

1. To create a basic interdisciplinary core of researchers working on monitoring the situation concerning SR in the area under investigation, to compare the collected findings and suggest changes in the given area.

2. To prepare legal bases for draft legislation changes, where they are needed to cover SR everywhere per areas.
3. To prepare professional, requisitely holistic bases for making up the SR program in all
ministries.
4. To establish dialogue with professional associations, government bodies, public
institutions, non-governmental organizations, businesses and other parts of society in
order to attain a shared activity for promotion of SR.
5. To include topics on SR in primary, secondary and higher education, and to promote
values of SR in daily mutual contacts of youngsters.
6. To create and implement a nation or EU wide program of public relations
communication about SR in order to promote general awareness on how crucial a SR-
based behavior of all humans and their organizations is for getting the society out of the
current crisis and to prevent long-term crises.
7. To establish a portal for both-way communication in public relations concerning the
SR-based behavior with both good and bad examples.
8. To collect good and bad examples of SR and related practices of RH and innovation
based on SR rather than on one-sidedness, for the society to become, be and remain an
RH/innovative society with SR as a basic criterion of its excellence.
9. To collect information on development of SR anywhere and in the area under
investigation in order to report about them.
10. To support initiatives of various stake-holders promoting SR and practicing it.
    
Tactics and operation should be defined later on per areas, but in the style of a
coordinated decentralization.

5. Ways to Implement RH by SR – the Case of Poverty needing SR

In order to implement the drafted strategy of SR, ethic of interdependence of several
essential professions and a democratic process of their practical co-operation, e.g. by
USOMID/Six Thinking Hats (Mulej and Mulej, 2006) or any other can be applied.

A RH approach, when we talk about problems of poverty in terms of SR, includes
in synergy the interdependent measures called solidarity, economic efficiency and RH
of monitoring, perception, thinking, emotional and spiritual life, decision making, and
action, in the following way:

- Solidarity, as we know it from Adam Smith, the e.g. Eastern Catholic, Islamic,
or Roman Catholic religions and on this basis from e.g. the socialist Yugoslavia and
older times of its areas, might be exaggerated. It is unrelated to contribution to social
well-being, thus an exaggeration and one-sided rather than RH, today. It supports the
lazy ones beside the needy ones. It diminishes motivation for work and even more so
for excellent work and innovation. The needy ones should keep receiving support, the
lazy ones should be granted responsibility for them-selves and training for detecting
and using their chances in market. Thus, solidarity may be less one-sided.

- Economic efficiency by the logic of the neo-liberal Chicago school of economics
is equally one-sided. It has an un-realistic supposition that the market is perfect with
no biased human impact. It therefore tends to leave every problem to market forces,
including the abuse of the law of external economics and abuse of the less innovative
by the more innovative ones and other power-holders, even when they apply very
narrow-minded and short-term criteria of economic efficiency. Thus, it leads to a
fictitious quality of life, business and general economic and social situation, which is
actually a blind alley caused by transformation of the A. Smith’s model of market
economy into a plutocratic fictitious one that is closer to the feudal times against
which the founding fathers of USA have fought (Goeiner et al, 2008). Unfortunately,
Baumol et al (2007) are too one-sided to perceive the blind alley of their suggestions.
- Holism, as a response to one-sidedness and over-sights caused by one-sidedness, does not mean that the upper levels in the organizational hierarchy are right in all situations and processes. It rather means an attitude that completely all attributes from completely all viewpoints and synergies of all of them must be considered. This requirement reaches beyond natural human capacities. One can come close enough to it, if one applies the Mulej and Kajzer’s law of RH (Mulej, Kajzer, 1998a, b). It puts in synergy all essential viewpoints (Figure 1). Ethic of interdependence expresses values enabling this. In the given case this includes weighing and concerting of solidarity and economic efficiency, in order to provide to humans an equilibrium with no resulting need for too much solidarity or too much protesting against the one-sided decisions and actions of authorities all way to terrorism.

As ways to make such equilibrium attainable, one can use two essential recent findings in economic literature:

- Florida (2002, 2005) found in a comparative analysis of US regions that the best development had been attained in regions with the highest 3T: tolerance for differences between habits of the (honest, of course) people attracts talents and hence it makes sense to invest in technology there. Mala_i_ et al. (2006) found equal situation in Slovenia.

- Porter (1990, 2006) pointed out that the basis of competitiveness evolves in four phases: from natural resources via investment to innovation and hence to affluence, which people have always wished to have. But affluence has a crucial side-effect: affluent people have no motive any longer to work in order to have, which results in a growing need of many citizens for solidarity etc. In affluence sources are not scarce, but real needs, while marketing and advertisement try to persuade people to have wants and try to buy like wants would be needs. (See also: James, 2007). Baumol et al. (2007) do not even mention or quote Porter, but they remind of this danger with a single quote (p. 288).

Hence, a more detailed and precise insight in poverty might be needed.

6. Old and New Kinds of Poverty – Various Kinds of SR May Help

A rather RH approach detects several kinds of poverty, and each and every one of them requires a specific approach to mastering it (Mulej, Hrast, 2008).

- The given economic situation of those whose natural attributes do not allow their easy adaptation to the current market forces includes the needy ones: children, pregnant women, mothers of small children, ill or handicapped or old persons. For them solidarity of the European style of so far should remain and be applied around the world.

- The given economic situation of those, who are too poorly adaptive to current market changes in terms of their professions and permanent residence. For them, solidarity should include training for more modern jobs or professions and education for more modern values.

- The given economic situation of those, who fail to think, decide, and act requisitely holistically, including a lack of innovativeness, which means a lack of a synergy of inventiveness, entrepreneurship and persistence. For them, too, solidarity should include training and education for more modern values.

- The given economic situation of those, who in their home areas in Africa etc. cannot find jobs because of the power-holders and owners, both local and international, acting with no SR. For them, solidarity should include creation of preconditions for SR of power-holders and owners toward employees and other
citizens, who should receive a possibility to live well enough at home rather than in Europe, US, etc.

- The coming new economic situation of the most advanced economies of the world facing affluence. It kills the basis of the usual economic theory and practice. In affluence there is no more the need to cover needs with lacking resources. Supply is much bigger than demand. Hence suppliers try to find their way out from their blind alley with creation of more and more fictitious and artificial needs/wants, innovation, total quality and excellence, low prices and broad range. But they neglect natural environment too often at the detriment of health, happiness of people, and at the detriment of future generations condemned to cover the uncovered huge cost of eco-remediation. Affluence causes another blind alley, too: destruction of ambition to create and work in order to have, and growth of abusing drugs, alcohol, etc. It should be replaced by creativity and creation, because creativity is the most human attribute.

Can innovation show the way as it used to do, and be defined, so far?

7. Innovation – in Need of Innovation to Become Requisitely Holistic and Beneficial

Contemporary customers require excellence. The earlier level of quality cannot become a new excellence without innovation. Contemporary humans are condemned to living for innovation and on innovation, although this may be a huge burden for very many. We live in the first period of history in which routine is no longer good enough, after all hundred and more millennia of humankind.

Humans, who are living now, are living in the time in which innovation has become as frequent and unavoidable as never before. In the innovative society/economy humans must master much more entanglement than ever before:
- There are no longer local markets hidden and chances for many humans to live with old routine only;
- There are no longer markets in which demand is bigger than supply, except for the least advanced areas in which close to a billion people are hungry, while in the other areas about a billion people are too fat to be healthy;
- There are no longer many areas in which humans can live with no innovation and therefore with no RH thinking, called systems/systemic thinking in systems theory; etc.

Still, there are very few humans around the world, who are allowed to teach systemic/holistic thinking. The role of the narrow specialization, which is unavoidable, is so strong, that people hardly see that RH thinking makes specialization of any profession much more beneficial than any specialization alone. Nobody, whatever is their profession, can live well without co-operation with specialists of other professions. SR might help.

Good fifty years after the authors of Systems Theory had succeeded in making this theory known, and politicians of the world had succeeded in using it (informally) by making the United Nations Organization as the most holistic political organization of humankind, the European Union (EU) found it necessary to explicitly link ‘systemic’ view with innovation. In (EU, 2000a), EU after reminding readers of its previous documents enhancing innovation, states on p. 6:

‘The Action Plan’ was firmly based on the ‘systemic’ view, in which innovation is seen as arising from complex interactions between many individuals, organizations and environmental factors, rather than as a linear trajectory from new knowledge to new product. Support for this view has deepened in recent years.’
The empirical experience- and references-based understanding of the background of this excellent definition of systems thinking and its relation to innovation reads:

- Very few humans are by their nature and education capable of interdisciplinary co-operation, because specialists teach specialists to be specialists, including being proud of their specialization. This teaching is O.K., but not enough: it may cause hiding from reality behind the walls of one’s specialization, and lacking respect (1) for other specializations and the need of all of them for each other as well as (2) for their capacity to solve real problems in interdisciplinary creative co-operation much better than in separation (Ackoff, 2001, 2003; Gigch, 2003). Isomorphisms are not enough.

- The theoretical basis to learn the skills of the interdisciplinary co-operation stems from the original authors of the Systems Theory and Cybernetics. But many forget that the fathers of Systems Theory and Cybernetics have created their answers to the burning problems of their and our time in interdisciplinary approach, not by isomorphisms alone. This is where our Dialectical Systems Theory (DST) has come in good three decades ago to fill in the gap (Mulej, 1974; 1975; 1976; 1979; Mulej et al, 1992; Mulej et al, 2000; Mulej, _enko, 2004; Mulej et al, 2008; etc.).

- The well intended and well applied versions of systems theory, which describe a part of reality inside the viewpoint of one or another traditional, specialized, scientific discipline, do not match the above EU’s definition of ‘systems view’. Thus, they help people solve other problems, but not the one of RH of thinking, decision-making, and action, as a precondition of survival of humankind and the planet on which we live, and/or of success in any human action (Geyer, Hornung, 2003).

- The more or less traditional incentives for Total Quality as a way to innovation are often taken in a too bureaucratic way to really work as incentives for contemporary excellent quality as an incentive for innovation and RH to flourish (Pivka, Mulej, 2004; Pivka, Ur_i_, 1999; _kafar, 2004, 2006) and practice systemic thinking (SZK, 2007).

The problem lies in mentality very much – in humans’ thinking and worldview as well as other values/emotions. One-sidedness results in a lack of contemporary excellence, which requires more RH of observation, thinking, decision-making, and action for the contemporary international quality to result and the innovative society to exist.

8. The Law of Requisite Holism and the Contemporary Invention-Innovation Processes

Systemic thinking as the practice of RH rather than one-sided thinking had been many millennia old practice of the successful humans, before systems theory as its theoretical generalization was created. Boundaries of which Metcalf (2008) reminds may be too one-sided or match RH. Like most other human capabilities, the practice of systemic thinking was informal, first, and then received the form of theory to make easier the transfer of good practice through teaching (Mulej et al, 1998; Mulej et al, 2003; Mulej, N., ed, 2004; Poto_an, Mulej, Kajzer, 2002).

For our definition of RH thinking see (Mulej, in Mulej et al, 1992, reworked in Mulej, 2007a). It is based on Bertalanffy’s (1986, VII ff) notion that he had created the General Systems Theory against overspecialization, and not as one of many narrow disciplines. EU confirmed this notion well, as we see above. Holistic thinking requires more holism than the human natural capacity can cover. A specialized author (usually tacitly!) selects a viewpoint, to consider the object dealt with inside boudaries on the basis of limitation to one part of the really existing attributes only. When specialists of any profession use the word system to call something a system inside
their own single selected viewpoint – it makes a system fictitiously holistic. It does not include all existing attributes that could be seen from all viewpoints and all their synergies. We therefore suggest RH (Mulej/Kajzer, 1998, 1998a), see Fig. 1.

<table>
<thead>
<tr>
<th>Fictitious holism/realism (inside a single viewpoint/system, i.e. mental picture of the object)</th>
<th>Requisite holism/realism (a dialectical = inter-dependence-based system of essential viewpoints)</th>
<th>Total = real holism/realism (a system, i.e. totality of all viewpoints; equal to the object)</th>
</tr>
</thead>
</table>

Figure 1: The selected level of holism of consideration of the selected topic between the fictitious, requisite, and total holism/realism

For the RH to be achieved three preconditions, at least, matter:

1) Mutually different specialists in teams that feel ethics of interdependence and cooperate to attain the RH.
2) They include professionals from all and only essential professions/disciplines.
3) Their values are expressed in their ethics of interdependence and practiced in a creative teamwork, task force, session(s) based on an equal-footed cooperation rather than top-down one-way commanding.

RH thinking cannot include the global attributes only, because they make a part of the really existing attributes only, although they matter very much and tend to be subject to over-sight by specialists. Neither can RH thinking include the parts’ attributes only, although they matter very much and specialists of single disciplines and professions tend to focus on them. Relations, especially interdependences causing influences of parts over each other, must not be forgotten about in RH thinking. Especially specialists, who have not developed the habit to consider specialists, who differ from themselves, tend to make crucial oversights in this respect: they are not realistic enough.

RH thinking matters for scientific reasons, for individual success in whatever activity, and for economic reasons, too. See Fig. 2 and 3 for a quick look at changes requiring holistic thinking more and more today for success in innovative society reigning over the global market/life.
BUYERS’ MARKET | Growing impact of customers requiring satisfaction / total quality of products and services, and conditions of life | Big | Defined by buyers and consumers and pressing producers and suppliers to compete to meet requirements by innovation

GOVERNMENT SUPPORTED BUYERS’ MARKET | Increasingly organized / legalized impact of customers demanding total quality / excellence of products, services and conditions of life | Unavoidable | Defined by buyers and consumers and pressing producers and suppliers to compete to meet requirements by innovation; official quality standards are added; EU, e.g., requires holism

Figure 2: Development of market relations and innovation – a case of growing awareness of the requisite holism as a precondition of humankind’s survival and quality of life

Prescribed standards, such as ISO 9000 (quality), ISO 14000 (environment), are cases of the related change of the buyers’-market situation. In addition, in recent decades market changes became much quicker (Fig. 3).

Why many people today find facts in Fig. 1-3 alien?

People of today are overwhelmed by market demands for change and they must match these changes with innovation and hence RH and hence ethics of interdependence, like never before. Five major changes happened in one-generation time, rather than as slowly as people were used to earlier, and are keeping this speed.

For almost all of the 100.000 or millions of years of its history (Bryson, 2005), humankind has lived in self-sustained economy with a random market, e.g. in the form of fairs. Innovation did not matter; requisite holism was reduced to local and family relations, mostly, so was ethics of interdependence. In producers’ market this ethic and/or sustainable development did not matter either, because competition was negligible; cases may include medieval guilds, strong trade unions, or market monopolists of other types, including break-through innovations. Once monopolies had been broken, after 1870s (Rosenberg, Birdzell, 1986), innovation and hence RH and ethics of interdependence gradually became crucial – in the emerging buyers’ and state supported buyers’ market. Hence, in a very short period of time people have become supposed to change millennia old habits – add innovation to routine, and RH to growing narrow specialization, as well as interdisciplinary co-operation to self-sufficiency of specialists. Narrow specialization that is unavoidable today may support either ethics of interdependence or ethics of self-sufficiency, depending on human values and their resulting definition what is the RH in their cases.

<table>
<thead>
<tr>
<th>Decade</th>
<th>Market &amp; Social Requirements</th>
<th>Enterprise’s Ways To Meet Requirements</th>
<th>Type of Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-</td>
<td>Covering of post-war conditions of scarcity, rebuilding, etc.</td>
<td>Supply anything; supply does not yet exceed demand</td>
<td>Supplying Enterprise</td>
</tr>
<tr>
<td>1960-</td>
<td>Suitable price (as judged by customers)</td>
<td>Internal efficiency, i.e. cost management</td>
<td>Efficient Enterprise</td>
</tr>
<tr>
<td>1970-</td>
<td>Suitable price X” quality (as</td>
<td>Efficiency X technical &amp;</td>
<td>Quality</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th></th>
<th>commercial quality management</th>
<th>Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-</td>
<td>Suitable price X quality X range (as judged by customers)</td>
<td>Efficiency X technical &amp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>commercial quality X flexibility management</td>
</tr>
<tr>
<td>1990-</td>
<td>Suitable price X quality X range X uniqueness (as judged by customers)</td>
<td>Efficiency X technical &amp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>commercial quality X flexibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X innovativeness management</td>
</tr>
<tr>
<td>2000-</td>
<td>Suitable price X quality X range X uniqueness X contribution to sustainable development (as judged by customers)</td>
<td>Efficiency X technical &amp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>commercial quality X flexibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X innovativeness X sustainable development (SD), making in synergy one kind of social responsibility</td>
</tr>
</tbody>
</table>

Figure 3: From a supplying to a sustainable enterprise and increasing requisite holism

SR and RH is much more needed than in times of the local economy, and complex to attain.

Over the decades after the 2nd World War, market requirements have been changing more quickly than the human capacity to unlearn the old and accept the new culture. In every next decade, rather than a two-generation cycle of about 70 years (Mulej, 1994), new attributes preconditioned success in addition to the previous ones. Every phase after 1960, in the West (and Japan, Taiwan, South Korea, Hong Kong, Singapore, Australia and New Zealand) with their 20% of population of the world, expresses the buyers’ and state supported buyers’ market (in Fig. 2). Competition keeps causing lower cost, including a lack of care for natural environment, if short-term and one-sided views prevail. Monopolies are no better. A need results for costly eco-remediation, health care, organizational, managerial, business and technological innovation causing the development toward the sustainable enterprise (SE). We have no room here to enter details about them; see (Poto_an, 2002; Poto_an, Mulej, 2003, 2005, 2006, 2007; Poto_an, Mulej, Kajzer, 2005). Is this the final phase of humankind’s development/evolution? Can SR show the way toward RH and hence out of the blind alley?

9. After Innovation and Affluence – Well-being by Creativity and SR?

There is an interesting view of economic development phases that stresses the notions that are summarized in Figures 1-3. See Figure 4. (Porter, 1990, quoted after Brglez, 1999, 23-24). Porter speaks of competitiveness; we extend the idea to development and add our ideas about the related culture and phase 5. Obviously, the affluence phase in Figure 4 is not the highest development phase so far; only; it is also the phase of growing problems of employment, supporting everybody, growing lack of ambition and related drug etc. abuse, etc. Conclusion: one must attain and keep capacity of RH in order to enter the innovation phase quickly and remain in it as long as possible, and/or renew its culture. The latter may make room for a 5th phase, which is needed: the 4th phase can hardly be avoided. (Mulej, Prosenak, 2007). Porter and Kramer (2006) do not mention phase 5.

SE concept means, among the other points, that the traditional economic criteria can no longer express reality, because they oversimplify (like e.g. Forbes does, in Mulej, N., 2006). Criteria of sustainability diminish the impression of success of the socio-economic development to hardly any betterment of life over the recent decades (Bo_i_nik, 2007).
<table>
<thead>
<tr>
<th>PHASE</th>
<th>ECONOMIC BASIS FOR DEVELOPMENT</th>
<th>RELATED CULTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Natural factors</td>
<td>Natural resources and cheap labor, providing for a rather poor life for millennia</td>
<td>Scarcity and solidarity, collectivism, tradition rather than innovation</td>
</tr>
<tr>
<td>2. Investment in modern technology</td>
<td>Foreign investment into the area’s economic development; hardly/poor competitiveness in international markets</td>
<td>Growing differences, local competition, individualism, ambition to have more, be rich</td>
</tr>
<tr>
<td>3. Innovation based on local knowledge</td>
<td>Nation or region lives on its own progress and attain a better and better standard of living by international competitiveness</td>
<td>Growing differences and standard of living, global competition, ethic of interdependence, social responsibility, ambition to create</td>
</tr>
<tr>
<td>4. Affluence</td>
<td>People have finally become rich, which makes them happy in material well-being as a blind alley</td>
<td>Complacency, no more ambition, consumerism; what is quality, then?</td>
</tr>
<tr>
<td>5. Holistic creation and social responsibility (SR)</td>
<td>Material wealth suffices; effort aimed at spiritual wealth, healthy natural and social environment as requisitely holistic well-being</td>
<td>Ethic of interdependence and SR, ambition to create, diminish social differences to those caused by creation, including innovation</td>
</tr>
</tbody>
</table>

Figure 4: From scarcity via complacency to the danger of a new scarcity or a new, 5th phase

Cost of humans’ natural environment is only postponed to the next generations due to the lack of RH in business criteria of so far and today (Stein, 2007): it can diminish world’s GDP by as much as 20% very soon.

SE criteria are more realistic, but not enough, perhaps; criteria concerning well-being may serve, too.

Diener and Seligman (2004) offer a promising model. It includes important non-economic predictors of the level of well-being, such as social capital, democratic governance, and human rights; all of them influence work satisfaction and productivity well. Supportive social relations are necessary for well-being; well-being in its turn also leads to good social relationships with crucial economic policy implications. Desirable outcomes, even economic ones, often result from well-being rather than the other way around. People high in well-being later earn higher incomes and perform better at work than others. They also have better relationships, are healthier, and attain longer lives. Therefore these authors suggest measuring well-being with variables such as positive and negative emotions, engagement, purpose and meaning, optimism and trust, and life satisfaction. SR pays (Hrast, Mulej, editors, 2008).

Hornung (2006, p. 338) states that happiness is the permanent goal of humans and a holistic indicator of holistic well-being, well-functioning, and the physical, psychological, and social health of an individual.

What else should be added as criteria of the contemporary excellent quality based on innovation?

One can watch companies (Collins, 2001; Collins, Porras, 1997; Gerber, 2004; etc), individuals, countries, or regions. Florida (2005) found in field research, which
we have mentioned above, about the reasons of differences in economic prosperity between regions of United States two basic causes of them:

(1) In USA, the creative class is rising from 5 (five) percent a century ago to +30 % in 1999, with 12% in its super creative core, while the working class is dropping from 40% at its peak several decades ago to 25% now. The largest social group is the service class, but it does no earn much, because it only provides preconditions for the creative class to create most of all and for all (Florida, 2005, 90-99).

(2) In USA, the most prosperous regions have the highest 3T indicator: tolerance for difference between neighbors all way from traditional families to gays etc; talents that are attracted by tolerance and chances to be creative; technology invested (Florida, 2005, 257-273).iii Mala_i_ et al. (2006) found equal data and conclusions in Slovenia.

Tolerance is a relation making room for differences between humans to complement each other; it helps them to avoid oversights and to attain RH. Talents make the basis for creativity, including innovation, which in turn can best result from co-operation of specialists. Investment in technology supports their teams, and receives support from them: if various and different talents work hand in hand, results of their creativity have more chance to attain RH and succeed.

In other words: (informal) systems thinking is the back-ground of the creative class and innovative society. But it causes difference, obviously, because not all people are equally capable of RH thinking and creation, including innovation as a type of it.

But the affluence phase might be a dead alley, if people lose ambition for creation. People therefore need either a prolonged innovation phase based on RH invention- innovation rather than one-sided processes, or

a new phase, a 5th one, of creative happiness based on ethics of interdependence and interdisciplinary creative co-operation with SR replacing the phase of affluence; for selfish reasons, people are less selfish, short-term thinking, and narrow-minded, and they apply more RH.

To make this innovation of culture and economy happen, a part of population must become the core of the creative class: Lester (2005) found authors detecting that about 15-20% of people are willing to take risk and cooperate, about the same many want to be (abusing) free-riders, and the majority just waits to see, what will the opinion makers undertake. But this majority includes many humans with creative potential. Leaders providing role model of interdisciplinary creative co-operation can activate this potential rather than the commanding managers who do not. This would make humans happy and society prosperous. But it requires RH thinking.

This might lead to society and economy of (RH perceived) SR.

10. Society and Economy of Social Responsibility and Creation beyond Ambition to Have

SR is a new response to the issue of the need for RH as a difference making a serious difference. See Fig. 1 again, if necessary. Affluence is no problem as long as humans are RH in their observing, perception, thinking, emotional and spiritual life, decision making, and action; they include broader viewpoints, including indirect and long-term consequences and conditions of their actions. The RH rather than a fictitious one could hardly cause the culture of affluence. It would rather extend the ambition to create, including benefit of the entire society. RH and related ethics of interdependence can help humans join creative cooperation and perceive them-selves
as a part of the entire society/community (Mulej, Prosenak, 2007; Poto_an, Mulej, 2007).

Namely: SR is in the EU’s definition a concept for enterprises to integrate, on the basis of their free will, social and economic concerns into their business (including sustainability) and relations with stakeholders (IRDO, 2006). IRDO reaches beyond enterprises (ibid.): SR of individuals, organizations of all kinds, professional groups, nations, peoples, unions. Following several authors IRDO defines SR as the humankind's obligation to realize shared objectives of the society and to good beyond legal obligation. (Hrast et al, 2006, 2007; Hrast, 2007; Knez-Riedl, Mulej, _enko, 2001; Knez-Riedl, 2003a, b, c, d, 2006; Knez-Riedl et a, 2006). Such attributes of behavior create new ambition, reaching beyond complacency of the affluent ones. No short-term efficiency, including e.g. abuse of external economics, is enough, but happiness of many stakeholders that we have mentioned above.

11. Conclusions

The innovative society of today does not yield success in more than about two percents of all attempts to innovate and the high tech industries do not contribute more than five percent of GDP, at least not directly (Likar, Fatur, 2007). Innovative society is still limited to about 20% of humankind living in the oldest market economies. It is not successful, if criteria of sustainability are not added to the one-sided economic criteria. The Nobel Prize for peace 2007 confirms this. Even if the ‘West’ considers itself successful, research and public press report about increasing numbers of humans feeling unhappy and hence abusing drugs from alcohol to marihuana etc, and doing so at an increasingly young age. This is a sign that there is a lack of incentive for creation, for the Fromm’s transition from ‘owner to creator’, as the most human attribute (James, 2007). Such processes have been around before. The Roman and other empires have faced ruining, once their people entered affluence and became complacent. Hopefully, SR reaching beyond CSR to SR of all, and incentives, such as happiness based on creativity, can be a way out of the blind alley toward RH.

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ii X denotes interdependence. No attribute is avoidable any longer for a longer-term success. The original table (Bolwijn, Kumpe, 1990) did not contain X, but +. The sign + denotes that interdependencies and resulting synergies are not considered; elements are only summed up. This is an oversimplification. The original did not contain the decades of 1950 and 2000 either.
iii Tolerance to failures in business risk-taking is much bigger in USA than e.g. in Europe. This makes USA much more innovative. USA is a product of the most entrepreneurial Europeans, who left Europe to take their risk more freely. The routine-lovers remained in Europe and their culture keeps prevailing in it. Government can become more innovative in its processes and act as a big buyer in the buyers’ market to require all suppliers to all in public sector (of everything from toilet paper to top scientific findings) as well as all supplying these suppliers to excel in innovation, quality and SR; research organizations must establish marketing offices, other organizations must include search for knowledge in regular practices, and co-operate with research organization on the basis of ethics of interdependence (Mulej, 2007b). On the other hand, USA seems to be closer to one-sidedness of its entrepreneurs and politicians (Goerner et al, 2008). Goerner et al (2008) suggest therefore a new way of systemic thinking called the integral view and the new science of sustainability. Sally Goerner was an invited plenary speaker at the 50th ISSS conference, held at Sonoma University in 2006.
A SERVICE SCIENCE PERSPECTIVE

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ABSTRACT

A shift from production orientation to a service perspective has been occurring in business disciplines over more than a century. During the last decade, that shift has provoked the emergence of significant and fundamental changes in the traditional means of adding economic value. Those changes are pressuring academia to provide commensurate professional education. This paper examines important aspects of these advances and their implications for curriculum development. Key words: service science, curriculum, Living Systems Theory, innovation, traditional value stream, service value stream.

INTRODUCTION

Perspectives have limits. Recently, my granddaughter asked, “What does customer mean?” My reply was, “You know that. It is the person or company that buys your goods or services.” “No, Papa, this is about lions eating antelope.” I took the book and, to my amazement, the subject was environmental science instead of economics. As I read, I realized that the passage in question concerned the food chain—and the participants give their all. Service ad absurdum.

Notwithstanding the plethora of absurd perspectives masquerading as science, perspective is an essential element of discovery. Recently, the deterioration of a satellite designed to provide perspective made the news. It had been positioned in relationship to the Sun so as to give us the data to construct a three-dimensional view of our solar system. Multiple conceptual perspectives are every bit as important. It is in the conceptual realm of perspectives that paradigm shifts occur in science and in other disciplines of human inquiry.

This paper considers the service aspect of the shift of perspective from a supply push paradigm to that of demand pull. The fundamental shift is not new. It began to occur as the industrial revolution gave way to the preeminence of market and has accelerated since. That which is new is an emerging prevalence of the service perspective in the management and administrative literature. And, that prevalence is pressuring curricular change in professional education.

TRANSITION FROM TRADITIONAL BUSINESS VALUE STREAM TO SERVICE PERSPECTIVE

The traditional perception of the business value stream is supply push. While the terms used to describe the stream differ somewhat among disciplines, those of Figure 1 are
typical. The process starts with research and development and ends in customer service. The value stream describes an economic value added progression. The progression inures in the material systems. Each of the elements represents complex networks of the matter-energy subsystems described by Living Systems Theory (LST) (Miller, 1978).

<table>
<thead>
<tr>
<th>R/D</th>
<th>Invention</th>
<th>Design</th>
<th>Tooling</th>
<th>Procurement</th>
<th>Conversion</th>
<th>Production</th>
<th>Marketing</th>
<th>Distribution</th>
<th>Customer Service</th>
</tr>
</thead>
</table>

**Figure 1**

**Traditional Value Stream**

The service perspective of the business value stream is demand pull. Every business, and in fact every organization, is concerned with supply and demand. In the old perspective, production and distribution push demand to increase that which is being supplied. In the service perspective, demand pulls supply. The art of service is that of anticipating, forecasting, and supplying that which will be demanded. A science of service advances the propaedeutics of the art. That science begins with invention and design from a functional perspective. The difference in the old perspective and that of service is both perceptual and actual. Both perspectives concern all of the typically included value-added elements in the value stream. In the service paradigm, however, the initial emphasis is on discovery and prediction. The focus is the market and the customer. The service stream begins with customer service. The old value stream begins with research and development (R&D). The change of emphasis, of focus, from R&D to customer service coupled with a spiraling into organizational extension constitutes a significant paradigm shift. It is a shift from input-throughput-output perception to that of symbiotic relationship. Figure 2 illustrates a service value stream. A transition from the traditional value stream may be conceived to start with customer service and spiral through continuous improvement and materials recycle loops of the process of servicing customers. Figure 2 distinguishes among six pairs of related terms.

**Figure 2**

**Service Value Stream**

1a. Invention — to originate a device or process; as a practical matter, anything
that may be protected under patent, copyright, or trademark.

1b. Innovation — to originate a pattern of change in organization, such as in groups, organizations, and societies.

The term innovation as employed here, perhaps, requires the greater explanation. It is both more and less limited than that developing in current discussions. It is limited in its scope to social organization while being extended from conceptual to informational systems as defined by LST.

A wide body of literature is developing around the idea of innovation. The treatment ranges from means of inciting the dream, the science fiction that anticipates future technology, to the introduction of more analytic conceptual systems such as mediating spaces (Güney, Ing, and Simmonds, 2004), introduced as incubators of innovation and change. The theme that innovation may be enhanced by networking, synthesis, and even symbiosis runs through many of the discussions. Generally, the approaches rest on the two fundamentals that innovation progresses from the mental to the material and that the insight, the inspiration associated with its inception, is a process.

Innovation is mostly examined as a thought process, as conceptual systems. That is the case, even though the objects of concern are the advancing technology and complexification of human social organization. The approach reminds me of a statement that I believe is attributed to Queen Elizabeth I: “Life is but a bog. Those who trip lightly pass best.” The discussions are occasionally dirtied with the shortcomings of communication. But mostly, the discussions trip lightly over them. Perhaps we should consider that innovation may be as easily viewed to progress from the material to the mental. There, science may more directly contribute to the conversation.

The elevation of networking, synthesis, and symbiosis to causal process subsumes that harmony is a default position of human interaction. IBM’s Global Innovation Outlook 2.0 (2006) presents an almost transcendental vision of cooperation within and across organizational boundaries in quest of innovation. “Forget about free enterprise. Think enterprise free.” I wonder how many parents of more than one child would accept the harmony proposition at face value.

Despite their transcendental bent, the discussions are not esoteric or detached. They are an important aspect of the unfolding of a progressive understanding of innovation. The term innovation as a definitional element of the described service value stream, however, includes benefits, limitations, and consequences of dirtying origination with material informational actuation processes. Innovation feeds organization design as invention feeds artifactual design.

2a. Artifactual Design — to plan or delineate an original product or process.

2b. Organizational Design — to plan or delineate an original change in any social organization.
Service Science

3a. Tooling — to fit out conversion and production processes with the infrastructure by which the process occurs.
3b. Intervention — to come in to modify or influence organizational process and structural change.

The elements of conversion and production are seldom clearly distinguished. Their distinctive meanings are important for understanding the service value stream. I, consequently, use Miller’s definition of each to clarify the distinction.

4a. Conversion — to change “certain inputs to the system into forms more useful for the special processes of that particular system” (Miller, 1978, p. 3).
4b. Production — To form “stable associations that endure for significant periods among matter-energy inputs to the system or outputs from is converter, the material synthesized being for growth, damage repair, or replacement of components of the system, or for providing energy for moving or constituting the systems outputs of products or information markers to its supra system” (Miller, 1978, p. 3).

5a. Distribution — to divide and give out products and services.
5b. Extension — to stretch or to reach as to extend products and services. Extension may also be conceived as the extending of an entity’s boundary to take in the function of another entity that is being serviced.

6a. Customer Service — intermittent service provided to a customer.
6b. Service Customer — Continuous service provided to a customer.

The shift to service should not eliminate the older perspective. The service value stream by itself would eventually stalemate in current technology even against its symbiotic advantages, if the input-throughput-output perspective does not continue its contribution. That will happen because research and development (R/D) is not conveniently included in the continuous loop of Figure 2. R/D drives the traditional value stream. It is a costly and inconvenient add-on to the service value stream.

TRANSFORMATION FROM CUSTOMER SERVICE TO SERVICE CUSTOMER

The traditional value stream is transformed to a service stream by the introduction of innovation, organization design, intervention, extension and increased emphasis on conversion. Figure 3 illustrates the spiraling effect of those introductions.
TRANSFORMATION FROM PRODUCTION-DISTRIBUTION TO SERVICE

Some organizations deliver products; some deliver services. Products and services may be idealized as the extremities of a continuum from matter-intensive to energy-intensive processes.

Even more abstractly, the extremities may be viewed as form utility to place and time utility (Figure 5).

However the goods-services continuum is conceived, we must admit that there exist a lot more goods-services combinations than goods or services when they are defined in any objective or abstract space. Our concern is clearly with a continuum. Given that universal relationship between products and services, the inevitable question should be asked. Is there a universal transformation from products to services? At least one exists. Potentially, any product may be transformed into a service by taking the entire life-cycle of the product into the service process. For example, IBM’s early leasing policy and the commercial carpet leasing of Interface Incorporated (Anderson, 1998). Such
transformations both gain the symbiotic advantage and aid environmental sustainability by recycling damaged and worn products.

While the life-cycle approach to products may provide a universal transformation, the grand expansion of service undoubtedly lies in another relationship. That relationship is between energy and information. The relationship may be idealized as a transition of meaning between the terms negentropy and information. The direct transition (negentropy_information) is the acquisition of knowledge and the reciprocal (information_negentropy) is power of organization (Beauregard, 1961). These transitions form a cycle of service (Figure 6).

![Energy, Information, and Service](Figure 6)

**Figure 6**

**Energy, Information, and Service**

Given the service value stream, with its continuous improvement loop, the cycle spirals into multiple layers of service. Take, for example, the function of gate keeping in a public transportation system (such as that in Tokyo, Japan,) that incorporates privately owned as well as publicly owned segments (subsystems).

The function of gate keeping most basically involves a porter who obstructs entry to the vehicle until payment of fare is received. That function is labor intensive on a certain skill scale. The basic function may be modeled as an exchange (according to Swanson, 1993) as follows:

\[
CM_C^{1.0} CM_{TC}^{1.0} S_{TC}^{1.0} S_C^{1.0}
\]

where the main terms are CM = Currency Money and S = Service, the superscripts are C = Customer and TC = Transportation Company, the subscripts indicate objective value on
a monetary scale, and the chain begins with outflow from an entity followed by inflow to the other, followed in turn by the outflow of the reciprocating transaction followed by its inflow to the initiating entity.

At least two levels of skill are needed by the gatekeeper—physical obstruction and money-handling. The higher money-handling skill aspect of the function may be specialized with the introduction of prior ticket purchase. This allows the employment of lower skilled porters with a reduction of the number of workers at the higher skill level. That specialization divides the money-handling process from the service process by introducing a different type of information—a receipt (ticket). Now there are two exchanges:

\[
CM^C_{1,0} CM^{TC}_{1,0} R^{TC}_{1,0} R^C_{1,0} R^C_{1,0} R^{TC}_{1,0} S^{TC}_{1,0} S^C_{1,0}, \text{where } R = \text{Receipt}
\]

As it is discovered that the remaining skill needed by the gatekeeper is more mechanical than social, a machine is invented to accept the receipt and give access—relieving the porters for more socially productive work. The function of gate keeping is complicated when the tracks or routes of two companies are connected; a new informational layer is needed. Four exchanges are now required.

\[
CM^C_{1.5} CM^{TC1}_{1.5} R^{TC1}_{1.5} R^C_{1.5} R^C_{1.0} R^{TC1}_{1.0} S^{TC1}_{1.0} S^C_{1.0}
\]

\[
R^C_{0.5} R^{TC2}_{0.5} S^{TC2}_{0.5} S^C_{0.5} R^{TC2}_{0.5} R^{TC1}_{0.5} CM^{TC1}_{0.5} CM^{TC2}_{0.5}
\]

Both receipt information and money-information are exchanged among customers, transportation company one, and transportation company two. The more exchanges required, the more potential for information service exists. All service requires in some degree labor, materials, and energy facilitated by money-information. Consequently, that which seems at first to eliminate labor simply moves it to a higher level of service. Consider when multiple transportation companies are added to the system. For each additional transportation company, the following two exchanges are added:

\[
R^C_{0.5} R^{TC3}_{0.5} S^{TC3}_{0.5} S^C_{0.5} R^{TC3}_{0.5} R^{TC1}_{0.5} CM^{TC1}_{0.5} CM^{TC3}_{0.5}
\]

Since all transportation companies sell the tickets with transfer privileges, the customer initiated exchange and the initial service exchange plus all subsequent exchanges are performed by all companies. They, consequently, must each provide more and more specialized accounting and finance subsystems. That specialization provides the opportunity to introduce another level of service. A ticket agency can sell the tickets and distribute the money to each transportation company eliminating the duplicate subsystems and allowing the transportation companies to concentrate on their areas of expertise. In that specialization, no receipts and money are exchanged between transportation companies. The exchanges occur only between the ticket agency and the transportation companies.

\[
CM^C_{5.0} CM^{TA}_{5.0} R^{TA}_{5.0} R^C_{5.0} R^C_{5.0} R^{TC1}_{5.0} S^{TC1}_{5.0} S^C_{5.0}
\]

\[
R^{TC1}_{0.5} R^{TA}_{0.5} CM^{TA}_{0.5} CM^{TC1}_{0.5} \ldots, \text{where } TA = \text{Ticket Agency}
\]
Service Science

Consider now the customers of the transportation companies. The customers transit among the companies in different patterns in their daily or weekly travels. Obtaining tickets for specific routes becomes complex and confusing. That complexity provides another opportunity to introduce another level of service. Tickets denominated in money value can be issued to customers to gain access to the amount of service desired without regard to which transportation company is providing it. This, of course, also requires a new layer of machine gates with information loops relaying the value of the service rendered by each transportation company to the ticket agency and reciprocating loops of payment. Notice that the exchanges being serviced remain the same as the previous level.

\[
CM_{5.0}^C \quad CM_{5.0}^{TA} \quad R_{5.0}^{TA} \quad R_{5.0}^C \quad R_{0.5}^{TC1} \quad S_{0.5}^{TC1} \quad S_{0.5}^C \quad R_{0.5}^{TC1} \quad R_{0.5}^{TA} \quad CM_{0.5}^{TA} \quad CM_{0.5}^{TC1}
\]

Advancing technology drives this higher level of service. Another level of service may be provided by expanding use of the money-valued receipts to obtain products from vendor machines and even subway mall outlets. A further level is introduced with automatic banking through implementation of debit card systems, and still another level through the introduction of credit through credit cards.

PEDAGOGICAL CONSIDERATIONS OF THE SERVICE VALUE STREAM

Davis and Berdrow (2008) provide an interesting overview of progress toward a service science orientation made over the last decade in business school curricula. While the progress is significant, it is not yet beyond an incubation stage. They conclude: “We therefore need to take service science to the next level and include academics who previously had not considered the study and teaching of service science to be within their respective realms of research or teaching” (p. 38).

The Master of Business Administration (MBA) is widely accepted as the standard of professional education for the traditional business value stream. The question of its adequacy for the service value stream may be raised. It may be that the spectrum of knowledge exposure required for the MBA is necessary but not sufficient.

It is likely that a Master of Science in Service (MSS) should provide insight into the various elements of the traditional business value stream (the focus of the MBA)—research and development, design, tooling, procurement, conversion-production, marketing, distribution, and customer service. The depth of such insight, however, would have to be diminished to make room for special insight into the service value stream. The MSS should provide special professional insight into service customer, innovation, organization design, intervention, and extension. Systems science and methodology provides a promising foundation for this significant core of knowledge. Significant systems literature concerns innovation, organization design, and intervention.

Glushko (2008) references the discussion of “T-shaped people.” That discussion attempts to get at the need to educate individuals to varying depths of insight in several disciplines. He cites Brown’s (2005) definition of principal skill (e.g., engineering) as the vertical leg of the T and an ability to “explore insights from many different perspectives . . .” as the cross-bar (Glushko, p. 16). Glushko contrasts Brown’s view with that of IBM (2007) which defines the cross-bar as deep business skills and the
vertical leg as technical understanding. Brown’s positioning of technical understanding with deep knowledge (principal skill) cannot simply be tethered with IBM’s deep business skills in the frame of master-level education. Only 150 semester hours are available. Brown is correct as to the requirement for deep insight into the technical understanding of the functional processes that are to be serviced. That leaves only the cross-bar to be defined. There, curricular space dictates that the insight be something less than deep. I suggest two levels of insight be assigned to the cross-bar—general and specific.

The MSS and the MBA are structurally similar in that they both require an integrative core of knowledge. The two degrees, however, have very different content. The MSS provides three distinct classes of knowledge exposure. They are: (1) general insight, (2) special insight, and (3) deep insight. General insight roughly approximates that of a Masters Degree Minor (or Track). Special insight approximates that of an MBA core emphasis. Deep insight equates to that of business and engineering entry-level education requirements. General insight is provided into the traditional value stream processes. Special insight is provided into the service value stream processes. Deep insight should be obtained mainly through entry requirements. A baccalaureate degree providing deep insight into special processes should be a prerequisite to the MSS program. For example, an MSS with a major in design should require a BS in engineering design or other related undergraduate degree. Additional specialization should be introduced to the design major by requiring course work in research and development and customer service as part of the special insight provided at the Masters level. Another service target might be a production process. Industrial, mechanical, electronic, even nuclear engineers may be eligible for the MSS production major. Probably the industrial engineer is the natural candidate. The special insight course work for production major would include procurement and tooling.

Service may be introduced to customers in any of the value chain processes (Figure 7). Consequently, MSS degrees are likely to be more specialized than MBA degrees. The possibility that a major (or emphasis or track) approach might provide the conceptual space to incorporate the insights into secondary value chain processes should be considered.

The perspective of service technology as demand pull moves in the opposite direction to the supply push production-distribution technology. The inner circle of Figure 7 shows that the demand pull service technology begins with customer service and moves back through distribution, marketing, and so on. The outer circle shows that supply push begins with research and development and moves forward through design, tooling, and so on. Generally, a need for deep insight into the process that will be serviced exists and there also exists a need for some depth of insight into the two previous processes of the traditional value stream technology. That pattern is shown in Figure 7 by the broad-band, multi-shaded arrows. Two exceptions to that general rule are research and development and marketing. Research and development reaches back one process to customer service and forward one process to design. Marketing reaches back only one process to production. Possibly it also reaches forward to distribution.

The relationships discussed here are knowledge relationships. Pedagogical design is another matter. Programs could range from integrative in every course to an eclectic integration of courses.
Master of Science in Service

MSS AND THE MBA DIFFERENCE

The MSS and the MBA are clearly different degrees. One is not simply a variation of the other. While the structures are somewhat similar, the purpose and content of the Master of Science in Service (MSS) are almost completely different from that of the MBA. The MSS is concerned with the actual functional progressions of the value stream. The MBA is concerned with the management of the operations and their support functions of investment and finance (Figure 8). That management is exercised through interpersonal relations, group dynamics, and accounting and management information systems. The MBA student is taught to manage the technology and innovations that rise to the surface. The MSS student should be taught how the technology and innovations originate and rise.
The increasing specialization and the resulting complexity of economic processes have influenced the introduction of “tracks” in many MBA programs. Such tracks attempt to provide some depth of knowledge and understanding in a particular functional area. Most such tracks concern the support functions. Other MBA programs are being targeted at specific industries. All, nevertheless, continue to emphasize management as they should.

While some MBA programs have migrated somewhat from the general to the specific, development of the MSS should be a migration from the special to the general. The center of gravity of the MBA is the “core subjects.” The benefit of specialization is evaluated against its core costs. What general knowledge is surrendered. The MBA core is well policed by the interacting disciplines that provide content. The development of the MSS requires almost the opposite dynamic. It requires movement from the special to the general.

That process progresses in the following steps:
1. Identify the depth of knowledge required to function in each of the elements of the value stream.
2. Search systems science for bridging concepts, methodologies, methods, and techniques.
3. Structure core curriculum (or course) in systems science.
4. Structure extended curriculum of courses that state the special knowledge of deep disciplines in system terms. These courses should provide a certain depth of special knowledge associated with each of the elements of the service value stream.

5. The prerequisite of the MSS should be an undergraduate degree in one of the deep disciplines required to function in one or more of the elements of the value stream.

The MBA certainly provides general insight into the traditional value chain. Many engineers, computer systems specialists, management information system specialists, marketing majors, etc. have obtained MBAs. Those people should be prime prospects for matriculation into the MSS.

The question of where the MSS should rest in the traditional disciplinal turf of the university does not have a clear answer. The involvement of college of business seems necessary. Some specialties such as production might be better located in engineering while availing their students of certain business courses.

CONCLUSION

A significant transition in the way we think about business processes is taking place. The perspective is being drawn away from product to service. This transition reverses the perception of the structure of market from supply push to demand pull and transforms customer service from intermittent to continuous. In that transformation, innovation, organizational design, intervention, and extension are added to the traditional value stream. These changes significantly impact professional education requirements, so much so that a new class of master level degrees may be required.

REFERENCES


FAILURE OF FORESIGHT: LEARNING FROM SYSTEM FAILURES THROUGH DYNAMIC MODEL

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ABSTRACT

A dynamic model for holistically examining system failures is proposed, for the purpose of preventing further occurrence of these failures. An understanding system failure correctly is crucial to preventing further occurrence of system failures. Quick fixes can even damage organizational performance to a level worse than the original state. There is well known side effect of “normalized deviance” which leads NASA’s Challenger and Columbia space shuttle disasters. And there is so called “incubation period” which leads to catastrophic system failures in the end. However this indicates there is a good chance to avoid catastrophic system failures if we can sense the incubation period correctly and respond the normalized deviance effect properly. If we don’t understand system failure correctly, we can’t solve it effectively. Therefore we first define three failure classes to treat dynamic aspects of system failures. They are Class 1 (Failure of deviance), Class 2 (Failure of interface) and Class 3 (Failure of foresight) respectively. Then we propose a dynamic model to understand system failure dynamically through turning hindsight to foresight to prevent further occurrence. An application example in IT engineering demonstrates that the proposed model proactively promotes double loop learning from previous system failures.

Key words: system failure, engineering safety, dynamic model, double loop learning

1. INTRODUCTION

The purpose of this paper is to propose a dynamic model to promote engineering safety by learning from previous system failures. The predominant worldview in IT engineering is that systems failures can be prevented at the design phase. This worldview is obvious if we examine mainstream, current methodologies for managing system failures. These methodologies use a reductionist approach and are based on a static model (Nakamura, Kijima, 2008). It is often pointed out that most such methodologies have difficulty coping with emergent properties in a proactive manner and preventing the introduction of various side effects from quick (i.e., temporary) fixes, which leads to repeating failures of similar type. The main reason for this situation is that current methodologies tend to identify a system failure as a single, static event, so organizational learning tends to be limited to a single loop rather than a double loop in rectifying the model of the model (i.e., the meta model) of action
Failure of foresight: Learning from system failures through dynamic model

(i.e., the operating norm). Double loop learning skill should enable people to question basic assumptions, which leads to modifying mental models to create action producing desired goals, rather than simply modifying actions under current mental models (Morgan, 1986; Argyris, Schoen, 1996; Senge, 1990). Heinrich’s law (Heinrich, Petersen, and Roos, 1989) which is well known in the industrial world that state there are 29 minor injuries and 300 troubles in the background of a serious injury. This indicates that there are enough signs prior to a severe system failure or a serious injury. However explanations of system failures in terms of a reductionist approach (i.e., an event chain of actions and errors) are not very useful for designing improved systems (Rasmussen, 1997; Leveson, 2004). In addition, Perrow. (Perrow, 1999) argues that the conventional engineering approach to ensure safety – building in more warnings and safeguards – fails because system complexity makes failures inevitable. This indicates that we need a new model that can manage the dynamic aspects of system failure, by ensuring the efficacy of its countermeasures through the promotion of double loop learning. In this paper, we propose a new way to interpret system failures dynamically in order to overcome the current methodologies’ shortcomings. We also demonstrate the proposed model’s efficacy through an application in IT engineering.

2. TAXONOMY OF SYSTEM FAILURES AND INTRODUCTION OF THREE FAILURE CLASSES

Prior to explain safety archetypes we need to review taxonomy of system failures. We should have a common language for understanding system failure objectively. It is vital to examine system failure from various perspectives. System safety can be achieved through the actions of various stakeholders. One such common language was developed by van Gigch (van Gigch, 1986) for taxonomy of system failures. There are six categories of system failures. They are failure of i) technology, ii) behavior, iii) structure and regulation, iv) rationality and v) evolution. However common language is not adequate to treat dynamic aspect of system failures. Furthermore we need to introduce three failure classes in order to avoid the dynamic aspects of system failures (i.e., erosion of safety goals over time). The failure classes should intentionally be identified in conjunction with the VSM model (Beer, 1979, 1981). They should clarify the system boundary and the nature of a problem (i.e., predictable or unpredictable). The failure classes are logically identified according to the following criteria:

Class 1 (Failure of deviance): The root causes are within the system boundary, and conventional troubleshooting techniques are applicable and effective.
Class 2 (Failure of interface): The root causes are outside the system boundary but predictable at the design phase.
Class 3 (Failure of foresight): The root causes are outside the system boundary and unpredictable at the design phase.

The failure classes thus depend on whether the root causes are inside or outside the system boundary, and a class-3 failure for one person can be a class-1 or -2 failure for other people. Therefore, the definition is relative and recursive, so it is important to identify the problem owner, in terms of two aspects: the stakeholder group, and the VSM system (i.e., systems 1 to 5). Unless those two aspects are clarified, failure classes cannot be identified.
It is necessary to recognize the organizational system level in order to rectify the operational norm, because for preventing further occurrence of system failures, it is inadequate to change only systems 1 to 3 (or the phase system for seeking when and how). As pointed out above, current technological models mainly focus on the operational area, and this can lead to side effects of quick fixes. Event chain models developed to explain system failures usually concentrate on the proximate events immediately preceding the failures. The foundation of a system failure, however, is often laid years before the failure occurs. In this situation, the VSM model serves well for understanding real root causes.

In a stable environment, control of activities and their safety by a prescriptive manual approach deriving rules of conduct from the top down can be effective. In the present dynamic environment, however, this static approach is inadequate, and a fundamentally different view of system modeling is required. Next Section describes dynamic model (i.e. Safety Archetypes) explaining why fixing failures sometimes introduces unintended side effects and how dynamic understanding contributes to introducing ultimate counter measures.

3. UNDERSTANDING SYSTEM FAILURE THROUGH DYNAMIC MODEL

The frequent occurrence of deviant system failures has become regular but poorly understood. For example, deviant system failure is believed to lead to NASA’s Challenger and Columbia space shuttle disasters (Columbia Accident Investigation Board Report, Chapter 6, pp. 130). This normalized deviance effect is hard to understand from a static failure analysis model. NASA points out the notion of “History as Cause” for repeated disastrous failures (Columbia Accident Investigation Board Report, Chapter 8). And this normalized deviance is tightly relating so called “incubation period” prior to catastrophic disasters (Turner, Pidgeon, 1997; Vaughan, 1997).

These considerations imply usefulness to focus on the dynamic aspects of the cause and effect of system failures rather than the static aspects. Dynamic model analysis is applicable in all technology arenas, including high-risk technology domains like that of NASA. There are some pitfalls, however, in introducing countermeasures. Quick fixes seem to work in a short time span but gradually have a saturated effect in the long term or can even damage organizational performance to a level worse than the original state. This can be explained using a dynamic model of the safety archetype. There are well-known archetypes of fixes that fail, eroding safety goals and degrading the incident reporting scheme (Braun, 2002). Conventional dynamic models incorporate several key notations useful for examining systems failures. Table 2.1 summarizes the symbols used in these dynamic models. In particular, the system boundary notation in dynamic model representation is effective for preventing the introduction of side effects by reinforcing incorrect countermeasures. Symbol R or B can be combined with IC or UC; for example, BIC stands for a balancing intended consequences loop. The “+” sign indicates that an increase or decrease in state 1 causes an increase or decrease, respectively, in state 2. The “-” sign indicates that an increase (decrease) in state 1 causes a decrease (increase) in state 2. The problem and side effect archetypes clarify the leverage points of problems when introducing countermeasures.
Table 2.1 Symbols used in dynamic models

<table>
<thead>
<tr>
<th>Symbol/Notation</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Reinforcing loop</td>
</tr>
<tr>
<td>B</td>
<td>Balancing loop</td>
</tr>
<tr>
<td>=</td>
<td>Time delay of an effect</td>
</tr>
<tr>
<td>IC</td>
<td>Intended consequences (combination with R or B)</td>
</tr>
<tr>
<td>UC</td>
<td>Unintended consequences (combination with R or B)</td>
</tr>
<tr>
<td>+</td>
<td>Positive feedback loop</td>
</tr>
<tr>
<td>-</td>
<td>Negative feedback loop</td>
</tr>
<tr>
<td>Problem</td>
<td>Problem type of dynamic model</td>
</tr>
<tr>
<td>Side effect</td>
<td>Side effect type of dynamic model</td>
</tr>
<tr>
<td>Solution</td>
<td>Solution type of dynamic model</td>
</tr>
</tbody>
</table>

4. SAFETY ARCHETYPES IN ENGINEERING SYSTEM FAILURES

4.1 Overview of safety archetypes and its behavior through time

There are three strands of problem archetypes and solutions: (1) a system failure archetype for all failure classes; (2) an archetype of misunderstanding Class 2 and 3 failures as Class 1; and (3) an archetype of misunderstanding failures of Class 1 as Class 2 or 3. We exclude the third strand because all engineering system failures have technical components, so Class 1 is always within the scope of analysis. Figure 4.1 illustrates the transition of engineering safety archetypes through time. Both first and second strands have solution archetypes derived from single loop learning (third column in Fig. 4.1). These solution archetypes seem to work within a short period of time but then gradually introduce various side effects (fourth column in Fig. 4.1). The solution archetypes from double loop learning access the real root causes in order to enhance engineering safety (fifth column in Fig. 4.1). Sections 4.2 to 4.11 explain each scenario of the dynamic model shown in Fig. 4.1. Stage I, II and VI in Fig. 4.1 are explained in Table 4.1.
Failure of foresight: Learning from system failures through dynamic model

Turner and Pidgeon found that failure responsible organization had “failure of foresight” in common. The disaster had long “incubation period” characterized by a number of discrepant events signaling potential danger. These events were typically overlooked or misinterpreted, accumulating unnoticed. In order to clarify that mechanism, Turner and Pidgeon decompose time horizon from initial stage to cultural readjustment through catastrophic disasters into six stages (Turner, Pidgeon, 1997, pp.88). Table 4.1 shows the feature of each stage and its relation between six stages, Failure Classes and Safety Archetypes explained above.

Table 4.1 six stages of development system failures and its relation to safety archetypes

<table>
<thead>
<tr>
<th>State of development</th>
<th>Feature</th>
<th>Failure Class</th>
<th>Safety Archetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>Failure to comply with existing regulations Class1</td>
<td>Class1</td>
<td>System Failure Archetype (Fig.4.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Goal introduction (Fig.4.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reinforcement of current action (Fig.4.6)</td>
</tr>
<tr>
<td>Stage II</td>
<td>Events unnoticed or misunderstood because of</td>
<td>Class3</td>
<td>Complacency (Fig.4.4)</td>
</tr>
</tbody>
</table>
### Failure of foresight: Learning from system failures through dynamic model

<table>
<thead>
<tr>
<th>Incubation period</th>
<th>misunderstood because of erroneous assumptions</th>
<th>Class2 and 3</th>
<th>Misunderstanding Class 2, 3 failure as Class 1 (Fig.4.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events unnoticed or misunderstood because of difficulties of handling information in complex situations</td>
<td>Class2</td>
<td>Fix that fail (Fig.4.8)</td>
<td></td>
</tr>
<tr>
<td>Effective violation of precautions passing unnoticed because of ‘cultural –lag’ in formal precautions</td>
<td>Class1 and 3</td>
<td>Erosion of safety Goals (Fig.4.7)</td>
<td></td>
</tr>
<tr>
<td>Events unnoticed or misunderstood because of a reluctance to fear the worst outcome</td>
<td>Class3</td>
<td>Incentive to fewer incidents (Fig.4.7)</td>
<td></td>
</tr>
</tbody>
</table>

| Stage III Precipitating event | — | — | — |
| Stage IV Onset | — | — | — |
| Stage V Rescue and salvage | — | — | — |
| Stage VI Full cultural readjustment | The establishment of a new level of precautions and expectations | Class3 | Close disjunction between stakeholders (Fig.4.9) |
| | | | Introduction of absolute Goal (Fig.4.10) |
| | | | Enlargement of system boundary (Fig.4.11) |

### 4.2 System failure archetype (problem)

Figure 4.2 illustrates the system failure archetype. A system failure requires a counteraction that acts on the root cause and mitigates a Class 1 failure in the end. This is a very simple scenario, because the failure and its causes are within the system. The achievements of this archetype, however, saturate at some point of the time because of the BIC loop. If the saturation point of performance is well beyond the target or goal, this might not be an issue. Otherwise, we need another solution for this relative achievement situation in which the intended goal is not achieved.

![Fig 4.2 System failure archetype (problem)](image-url)
4.3 System failure archetype (solution)
Figure 4.3 illustrates the system failure solution archetype. A simple solution for system failure is to introduce a goal, and compare it with the current status, and adjust the action. This introduces a reinforcing action, until the goal has been achieved. This RIC loop breaks the balanced situation of the circle on the left side of the figure. This is a very simple scenario for the solution archetype of system failure. It is a typical example of single loop learning and is a predominant feature of current troubleshooting technologies.

4.4 Complacency archetype (side effect)
This problem archetype (Fig. 4.4) is the side effect of the system failure archetype (solution). The action loop of the system failure archetype (solution) continues for some time. This increases awareness of safety within the system boundary, which in turn generates oversight and finally leads to system failure again. This relative achievement situation explains why system failures repeat over a longer time span.

4.5 Misunderstanding Class 2 or 3 failure as Class 1 archetype (problem)
This archetype (Fig. 4.5) explains why system failure repeats after introducing a quick fix or inappropriate fix. It might reduce system failure in the short term and then gradually saturate the effect at a level below the organization’s goal. The BIC loop becomes open, with no further effect from the quick fix. The lower BIC loop in Fig 4.5 becomes open as a result of misunderstanding the system failure class and introducing no essential effects to solve the original problem.
4.6 Misunderstanding Class 2 or 3 failure as Class 1 archetype (solution)
This is a single loop learning scenario (Fig. 4.6) that introduces a reinforcing action based on the deviation from a predetermined goal. The RIC action to improve the situation escalates to the introduction of further quick fixes, only to repeat a similar scenario. The RIC action causes various side effects, including erosion of safety goals and an incentive to report fewer incidents. These side effects are hard to detect because the performance malfunction alarm becomes mute and management review can oversee these effects only by checking quantitative performance. This explains why such system improvement is bound to fail, as van Gigch (van Gigch, 1991) points out. In this relative achievement situation, a real root cause outside the system boundary should be dealt with.

4.7 Erosion of safety goals and incentive to report fewer incidents (side effect)
This side effect is introduced by an RIC loop that becomes tight without any further success in reducing system failures (Fig. 4.7). Increased pressure to achieve a goal emerges from the BUC loop by shifting the goal (i.e., lowering it) and hiding the real state of quality or safety from management. In this relative achievement scenario, a manager who stays within the system boundary has difficulty detecting the real state of achievement. This is why many Japanese manufacturers have a slogan of “3R-ism,” which ask managers to see if they have identified a problem at a “real site,” confirmed it with “real objects,” and discussed it with a “real person in charge,” before taking any action.
4.8 Fix that fails archetype (side effect)
Figure 4.8 illustrates a typical example of local optimization. The action taken for the root cause is a short-term solution to the problem and introduces delayed, unintended consequences outside the system boundary, which introduces a failure of Class 2 or 3. For example, an operations manager might shift resources from a proactive task team to a reactive task team because of a rapid increase in system failures, which would only cause the RUC loop to further increase the occurrence of system failures. This out-of-control situation can only be managed at the expense of others and damages the organization in a longer perspective.

4.9 Double loop learning for Class 2 failure archetype (solution)
It is necessary to focus on the possibilities of relative achievement or the side effects of a quick fix. A tacit assumption of stakeholder disjunction should be accommodated through debate to close the responsibility gap. Figure 4.9 shows this solution for the scenario shown in Fig. 4.5, misunderstanding system failure archetype (problem).
4.10 Double loop learning for class 3 failure archetype (solution)

As explained in section 2, the speed of technology advancement and growth of complexity are unpredictable. Therefore, a current goal could later become obsolete. This could be a real root cause of system failure, with no party responsible for the failure. In other words, the system failure emerges through no one’s fault. This kind of failure can be avoided by periodically monitoring goal achievement and benchmarking competitors. Figure 4.10 illustrates this scenario.

4.11 Double loop solution for fix that fails archetype (solution)

The solution of this archetype is to raise the viewpoint of the problem (Fig. 4.11). Class 2 and 3 failures become Class 1 if the presumed system boundary is enlarged. In addition, a solution link between groups would change the RUC loop to a BIC loop, which would be beneficial for achieving both groups’ goals.
5. ACTUAL APPLICATION SCENARIO APPLYING THE DYNAMIC MODEL AS DOUBLE LOOP LEARNING

Although above safety archetype has the capability to examine the dynamic aspects of system failures, a longer perspective like the “History as Cause” mentioned by NASA (section 4) should be intentionally employed in real application of the dynamic model. Reason (Reason, 1997) explains the organizational life span between protection and catastrophe. The lifespan of a hypothetical organization through production-protection space (Fig. 5.1) explains why organizational accidents repeat, with this history ending in catastrophe. This is why the side effects of dynamic movement should be confirmed.

We need to introduce OP matrix in order to confirm side effect properly. OP stands for objective and problem. The OP matrix is used to reveal disjunctions between objectives and problems in order to verify that current objectives fully encompass past system failures (Fig. 5.2). The first quadrant, where $(P, O) = (OK, OK)$, is the normal situation, because a goal has been achieved and there is no repetition of similar problems. The second quadrant, where $(P, O) = (NG, OK)$, might indicate a disjunction between stakeholders. This could be a manifestation of a problem for which no one has responsibility. The third quadrant, where $(P, O) = (OK, NG)$, might indicate a system failure that is not yet fully manifested. A goal might have to be altered in order to capture the real state of problem repetition. In the fourth quadrant, where $(P, O) = (NG, NG)$, a hard paradigm approach might be effective. Management
Failure of foresight: Learning from system failures through dynamic model

Malfunction (i.e., “extinct by instinct”) can cause this situation. The best practical scenario for applying the OP Matrix is during periodic management review.

We can use the OP matrix to understand why a system failure repeats or a fix does not work in the long term. Figure 5.3 shows a vicious circle of repeating system failures. This indicates that management review of engineering safety should be careful even if the current state is in the first quadrant, where \((P, O) = (OK, OK)\). The state can transfer to the fourth quadrant, where \((P, O) = (NG, NG)\), through introduction of the complacency archetype (Fig. 4.4). If the misunderstanding system failure archetype (Fig. 4.5) happens in the third quadrant, the situation transfers to another quadrant: the third, where \((P, O) = (OK, NG)\), for the erosion of safety goal archetype; or the second, where \((P, O) = (NG, OK)\), for the incentive to report fewer incidents archetype by reinforcing the current action archetype (Fig. 4.6). This is followed by a further transfer back to the first quadrant, giving management a false impression that safety goals have been achieved. This is another explanation of organizational navigation leading to catastrophe (Fig. 5.1), like the normalized deviation effects in the space shuttle disasters.
Failure of foresight: Learning from system failures through dynamic model

OP matrix helps to identify the long-term dynamic aspects of system failure and promotes double loop learning, as it changes the action model.

6. APPLICATION EXAMPLE: SERVER NOISE PROBLEM - DESIGN
FAILURE OR INSTALLATION ERROR?

In this example, a PC server user complains about the noise of running such servers in an office environment. It takes time for the PC server manufacturer to modify the noise design specification to conform to office utilization of the server. At the first stage, this is not treated as the designers’ fault, because there had already been a design norm for the noise level, and the server noise conformed to this predetermined level. The problem, however, is that the designers’ assumption of operation in a machine room environment was not communicated to customers. At the first stage, this is treated as a Class 1 system failure without further improvement in the situation. This introduces the side effects of erosion of goals and an incentive to report fewer incidents. If this system failure will be treated as Class 3, an evolutional malfunction, because the goals of the designers and the installer (or end user) have differed in time.

Countermeasures for only Systems 1 to 3 are inadequate, because the root cause resides in a soft system paradigm (Checkland, 1981; Checkland, Holwell, 1998), and Systems 4 and 5 should be modified to alter the design norm of the server noise level. Raising the countermeasure into System 4 and 5 is important for reflecting the noise level specifications of other servers (for example, a UNIX server, as opposed to a PC server). This will prevent other server problems by also modifying the design norm for the UNIX server. Figure 6.2 shows the differences in prevention level between

Fig 6.2 Vicious circles indicating repeated system failures.
Failure of foresight: Learning from system failures through dynamic model

reality, modeling, and meta modeling. These differences are also confirmed by using the dynamic model. If the noise problem is treated as a Class 1 failure, the side effects of erosion of safety goals and an incentive to report fewer incidents will appear in the long term (Fig. 6.3). This is the state of “normalized deviance” as mentioned above. We need to reinterpret this Class 1 failure as Class 3 failure turning hindsight to foresight. Figure 6.4 illustrates that treating the noise problem as Class 3 will lead to essential resolution. This dynamic model is quite powerful, and it is easy to understand that problems at the levels of Systems 4 and 5 should be escalated to the management layer. This avoids unnecessary cost in reaching a final decision to lower the noise level norm at the design phase.

![Diagram](image)

**Fig 6.2** PC server noise failure and prevention level
Failure of foresight: Learning from system failures through dynamic model

In this example, the mental model is changed through introduction of an absolute (ideal) goal by benchmarking competitors. The operating norm is changed by changing the design goal (i.e., the noise level), and the current process is changed by changing the operating norm. Dynamic transition of turner’s six stages is shown with OP matrix in Fig 6.5. Double loop learning is achieved through incubation period with some side effects (i.e. misunderstanding failure class, reinforcing current action and incentive to report fewer incidents).
7. CONCLUSION

The concept of an inquiring system (IS), introduced by van Gigch (van Gigch, 1991), describes how the black-box concept is elaborated as a decision-making process. Epistemology consists of the thinking and reasoning processes by which an IS acquires and guarantees its knowledge. Furthermore, epistemology converts evidence into knowledge and problems into solutions, designs, or decisions. Learning at the meta level modifies mental models, while at the model level, it changes the desired goal and the current operating norm, and at the reality level, it changes the operation. The outcome of double loop learning is an epistemology of experience. The example in section 6 demonstrates that the proposed meta methodology can actually promote double loop learning. The epistemologies acquired through this example turning hindsight to foresight are as follows.

i) Enlarge system boundary as much as possible to convert a system failure of Class 2 or 3 to Class 1.
ii) Sense “normalized deviance” state and respond Class 3 failure.
iii) Close stakeholder disjunctions to reduce Class 2 failures.
iv) Set absolute goals to reduce Class 3 failures.

The example also shows the efficacy of this methodology. If the level of countermeasures is raised up to the meta model layer, the effect of the countermeasures is increased; otherwise, similar problems would repeatedly occur sometime later. The predominant methodologies are only effective when a system failure is Class 1. Management pressure on Systems 1 to 3 as Class 1 failures causes various side effects and damages the organization in the long term. Reflective
Failure of foresight: Learning from system failures through dynamic model

recognition of system failures by using this dynamic model and its related tools can show the way to establish engineering safety even in uncertain, rapidly changing environments.

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THE TRADITIONAL MORALITY OF TOTALITARIANISM
-Analysis of Juche Ideology through Honoring Parents-

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ABSTRACT

The hyo (filial piety) system of Juche Ideology of the North Korea that leans excessively upon the hyo of obedience gives rise to the criticism that the North Korean political system is too extremely totalitarianism. To keep the North Korean system through Juche Ideology, the regime needs to make use of friendship of hyo in Juche Ideology too. Once the North Korean people's demands are satisfied properly through friendship of hyo, Kim's regime can invigorate the North Korean people to overcome their difficulties. If Jung Il Kim harmoniously makes use of the hyo of obedience and the hyo of friendship in Juche Ideology, he will succeed in keeping his power alive and developing the North Korea regime together.

INTRODUCTION

After the death of Il song Kim in 1994, many believed the North Korean regime would not survive. But the totalitarian regime of Jung Il Kim, son of Il Sung Kim is still alive. How did this regime manage to survive, though there was much crisis at the beginning of the regime?

As David Easton said\(^1\), the subsistence of a political regime depends on the capability of the political community, regime and authorities. As Chul Ho Park disagrees,\(^2\) the belief that Kim's regime in North Korea was saved because the regime or authorities of North Korea had the capability to survive is nonsense. Then what has allowed the North Korean political system to survive?

The primary reason for Kim's regime's survival is an ideology of the North Korean political community. This ideology is Juche\(^3\) Ideology. The political community composed of North Korean people supports the regime and authorities by Juche Ideology free of their capabilities of governing the state.

As Easton said,\(^4\) ideology is the last wall to protect the legitimacy of a political system. In order to operate, every political system needs the integration of the political community. Ideology is the primary mechanism to integrate a political community.

Juche Ideology has helped to integrate the North Korean political community and to strengthen Kim's totalitarian regime. Now we are interested in Juche Ideology as a

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\(^2\) Chul Ho Park, "The Analysis of the Political System of North Korea in Relation to the Possibility of Change and Existence, " *International Relations and the Reunification Issue* (Inchon: Incheon University Institute Peaceful Reunification, 1995), 107-122.

\(^3\) In Korea language "Juche" means a sense of sovereignty (and independence).

\(^4\) David Easton, *A systems Analysis of Political Life*. 
mechanism of integration for the North Korean people and a mechanism that empowered the survival of Kim's regime.

In this viewpoint, we are interested in the character of Juche Ideology and we want to investigate Juche Ideology structure. In order to understand the structure of Juche Ideology, we must first understand hyo, that is, the filial piety system that is a primary part of Juche Ideology.

The process of this study is, at first, to construct the model of analysis for Juche Ideology, next, to analyze Juche Ideology, finally, to suggest conclusion.

TOTALITARIANISM AND THE HYO SYSTEM OF GENERALIZING POSSIBILITY

1. Totalitarianism and traditional basic morality

As above statements, Jeung Il Kim’s regime is described the totalitarianism. What is the totalitarianism? And how does ideology do function the subsistence of the totalitarianism? Now, let us analyze these issues.

There is significant controversy over the terms totalitarianism. In relation with totalitarianism, Lawrence Aronsen, Karl Popper, Hannah Arendt, Carl Friedrich, and Juan Linz have each described totalitarianism in a slightly different way. But there is a common to all definitions. According to these scholars, totalitarianism is to attempt to mobilize entire populations in support of the official state ideology, and the intolerance of activities which are not directed toward the goals of the state, entailing repression or state control of business, labor unions, churches or political parties.

In history, totalitarianism, employed in the writings of the philosopher Giovanni Gentile, especially stresses the ideology of state that influences over most its citizen, if not power. In the view of ideology, totalitarianism is different from authoritarianism. Usually authoritarianism, unlike totalitarianism, lacks a guiding ideology. Speaking of otherwise, totalitarianism more stresses the ideology than authoritarianism.

Except of an elaborating guiding ideology, totalitarianism, as Carl Friedrich and Zbigniew Brzenzinski explain, is comprised with a single mass party, typically led by a dictator, a system of terror, a monopoly of the means of communication and physical force, and central direction and control of the economy through state planning. Of course, these elements of totalitarianism operate mutually supportive organic entity.

But why is ideology more stressed than other elements of totalitarianism?

5 http://en.wikipedia.org/wiki/Totalitarianism#Origins
6 Ibid.
7 Various differences can reflect the difference between authoritarianism and totalitarianism. First, authoritarian leaders, although often they repress their political opponents, may also leave a larger sphere for private life than a totalitarian government. Unlike totalitarian governments, authoritarian governments usually lack a guiding ideology, tolerate some plural is in social organization, lack the power to mobilize the whole population in pursuit of national goals, and exercise their power within relatively predictable limits.
According to Arendt, the source of the mass appeal of totalitarianism is its ideology which provides a comforting, single answer to the mysteries of the past, present, and future. For Nazism, all history is the history of racial struggle and for Marxism, all history of class struggle. Once that premise is accepted by the mass people, all actions of the totalitarianism could be justified by appeal to the ideology.

Strictly speaking of, ideology does not only consist in the advocacy of ideas. Rather, it informs talking, writing, thinking, working, making love, dreaming, raising kids...It is inscribed in the way we do these things and in the very language that substantiates the discourses of law, physics, TV sitcoms, education theory, bohemian culture, medical procedures, etc. At last, ideology is, in effect, not only the condition of all conscious life but also condition of existence itself.

Because ideology is condition of existence, ideology is fundamental value-laden. The fundamental value contains generally basic traditional moral elements that are in effect acknowledged in present society. Therefore, ideology of totalitarianism likes to use the basic traditional morality because the basic traditional morality generally has strong power of integration of society. The basic traditional moral elements are mostly rooted in the life of family or community. In totalitarianism, political leaders form the relation of them and their people on these elements to confirm, sustain, and expand their political power.

Generally, basic traditional moral elements have an important function to integration which is also the main function of ideology. Integration would deepen our incorporation in a socially empowered system, whatever that system may be. It would make us functionaries of the system. Therefore, the basic traditional moral elements justify political hegemony and its exercising. The language of these elements is intended to impose silence. Through the basic traditional morality of ideology, the existing social formation, which is little more that the inequitable distribution of power as it has been legalized, mediated and ‘naturalized’ in the form of a complex system, reproduces itself and its relation of new production by produce a new people, not just biologically but socially.

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10 [http://www.lus/dd.net/essays/ideology.html](http://www.lus/dd.net/essays/ideology.html)
11 Ibid.
12 As Noman Chomsky notes, it is necessary to control not only what people do, but also what they think. It is necessary to establish a framework for possible thought that is constrained within the principles of the State religion. These need not be asserted; it is that they be presupposed framework for thinkable thought. The critics reinforce this system by tacitly accepting these doctrines and confining their critique to tactical questions that arise within them. To achieve respectability, to be admitted to the debate, they must accept without questions inquiry the fundamental doctrine that the State is benevolent, governed by the loftiest intentions....The more intensely the debate rages between hawks and doves, the more firmly and effectively the doctrines of State religion are established. It is because of their notable contribution to thought control that the critics are tolerated, indeed honored. Therefore the deepest silence may be produced by criticism itself. That is, ideologized criticism within a system may be the most effective confirmation of that system. Noman Chomsky, “The manufacture of Consent,” *Our Generatio* 17:1(Fall/Winter 1985-86), 100-101. Recitation; [Http://www.lus/dd.net/essays/ideology.html](http://www.lus/dd.net/essays/ideology.html)
The Traditional Morality of Totalitarianism

In the process of these integrations of traditional morality of ideology, the extreme totalitarianism, as Chomsky criticized, becomes to a form of state religion. The highest leader gradually becomes to a god because people acknowledge him as a charismatic man like god. For example, there were Hitler of Nazi, Stalin of Soviet, Mutating of China, and North Korea of Ill Sung Kim and Jung Il Kim etc. In the state religion of totalitarianism, people take their charismatic leader in the form of the possessor of the ruling force of society.

People of the state religion of totalitarianism accept without questions inquiry the fundamental doctrine that the state which the charismatic leader rules is benevolent, governed by the loftiest intentions of the leader. The more intensely the legitimacy of ideology of totalitarianism and idolizing of charismatic leader, the more firmly and effectively the doctrines of State religion are established. Therefore the deepest silence of people may be produced by these processes of idolizing. That is, the establishment of state religion by idolizing of leader within a system of totalitarianism may be the most effective confirmation of that system. At last, in the state religion, the most honorable moral element is an entire obedience. In state religions, most people obey commands of their charismatic leader either with voluntary or through oppressing. But, generally what we understand is that the state religions of extreme totalitarianism is changed. Some have disappeared, some are transformed into other regimes and some remain. This study focuses on the North Korea as an extreme totalitarianism. More specially, our concern is how North Korea may be changed.

In relation to changing of North Korea totalitarianism, North Korea needs to investigate the relationship between Juche Ideology and the hyo system. We need to understand the Hyo System of Generalizing Possibility because the Hyo System of Generalizing Possibility helps us investigate the character of Juche Ideology. What is the Hyo System of Generalizing Possibility?

2. The Hyo System of Generalizing Possibility

On studying of hyo among the religions of the world, we have found that most religions have an interest in hyo. Especially Confucian, Buddhism, Christianity, and Islam emphasize hyo very much. Of course, there is some difference among these religions about hyo. But generally speaking of, hyo of these religions have largely four elements. The four elements of hyo are obedience, friendship, persistence and attorney.

The hyo of 'obedience'-emphasized at most in the filial piety of oriental and western beliefs-states that children should follow the will of their parents sincerely in order to please their parents in daily life and to follow their parents' wishes.

13 Here, the concept of ‘extreme’ contains meaning that an image of a leader of totalitarianism has a character of a god.

14 It is generally said that except regimes of these political leaders, the communist totalitarian regimes were original totalitarianism.

15 In this respect the Christian hyo system from the Ten Commandments of the Old Testament and family precepts of the New Testament can be universal too. From the systematic point of view, we need to recognize the Hyo System of Generalizing Possibility is rooted in the Christian hyo system in a compositive and multidimensional relationship. The beliefs of the Hyo System of Generalizing Possibility are obedience, friendship, persistence and attorney. These beliefs can be found the Bible in the book of Ephesians 6:1-4. Ephesians 6:1 speaks regarding obedience and agency, 6:4 friendship, and 6:3 persistence. Ephesians 6:1-4 states.
In the Christianity, the obedience of children to their parents is explained in the relationship between God the Father and His Son Jesus. The relationship of God the Father and the Son Jesus has two characteristics; vertical and horizontal. As Augustine said in his theory of the Trinity, the vertical relationship is Jesus' obedience to God the Father. This relationship gives us a model of how children should obey their earthly fathers.16

In this relationship, the earthly father or mother has the authority and power to achieve his/her will. Through this hyo of obedience, children learn to follow a social order within the family and within society. According to the Encyclopaedia Britannica,17 this parents' character in the parent/child relationship can be called the 'pater'.

The hyo of 'friendship' is the relationship between parents and children when they respect each other as equal persons and share friendship in a horizontal way. Being different from the pater parents, the parents of friendship keep a horizontal relationship with their children. The characteristic of these parents is called 'the genitor parents' that is well introduced by the Encyclopaedia Britannica.18

The relationship of genitor parents and their children is rooted in the mutual equality of people before God or social law. So this relationship is characterized by love and affection. Of course, children may keep the relationship of friendship. Therefore parents and children need to have much time to mutually discuss the wants of the parent and the child.

Parents should not exasperate their children. To exasperate a child is to treat a child impersonally. So parents should bring them up in the training and instruction of the Lord. If the friendship between a parent and a child is properly constructed, a child will follow his/her parents for a long time.

The hyo of 'persistence' means to supply what parents need to survive and continue. And it is made possible by the physical and material blessings through the hyo of obedience and friendship.

The hyo of persistence requires that children help provide their parents with the basic needs of life: food, clothing and shelter. In addition, children should take care of their parents' health with the materials and minds. These hyo activities allow for parents' long life.

And the hyo of 'attorney' means the origin of hyo is in God or natural law; we must practice hyo by friendship and through obedience to parents as the agent of God or natural law according to the God's Commandments or natural orders.

The hyo of attorney emphasizes that children should practice hyo in the God's Commandments or natural orders. In other words children should not practice hyo based only their will, concerns, or experience. Along with the will of God or natural

18 Ibid.
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order, children should practice the hyo of obedience, the friendship of hyo, the hyo of persistence. These are the elements of the Hyo System of Generalizing Possibility.

Below picture is the interaction net of above elements of the Hyo System of Generalizing Possibility.\(^1\)

![Interaction Net of Hyo System Elements]

**The Schema of Hyo System of Generalizing Possibility**

Now, let’s analyze the contents of Juche Ideology by the Hyo System of Generalizing Possibility.

**ANALYSIS OF JUCHE IDEOLOGY BY HSGP**

1. Hyo presented in Juche Ideology

Juche Ideology as it relates to Kim's regime was based in Kim IL Sung's Juche Ideology and has stood for 40 years. What are the contents of Juche Ideology?

Juche Ideology is composed of four theories. The four theories are 'the theory of revolutionary leader’, 'the theory of social-political life’, 'the theory of the great socialist family', and 'the theory of revolutionary morality’.\(^2\)

Now let's study the relationship between these four theories and hyo.

1) Hyo presented in theory of revolutionary leadership and the theory of social-political life.

According to the theory of social-political life and the theory of revolutionary leadership, Jung IL Kim and his North Korean people constructed a blood relationship that allows coexistence between them whether in life or in death, in sorrow or happiness and so on.

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\(^1\) Here, the sign of arrow means the interaction of among factors of the Hyo System of Generalizing Possibility.

\(^2\) ‘the theory of revolutionary leader’ and ‘the theory of social-political life’ have an affinity for each other, and, ‘the theory of the great socialist family’ and ‘the theory of revolutionary morality’ also have an affinity for each other. Therefore we discusse these theories by two part according to the affinity.
According to these theories, the captain leader gives political life to his people even as real parents give physical life to their children. More exactly speaking, 'the captain leader as a father' and 'the party as a mother' give social-political life to his people. So the captain leader as a father is the supplier of political life which is much more valuable than physical life.²¹

In these meanings, the captain leader, the political party and the people are a family made from the blood relationship of political life. The people are required to repay, by hyo, the captain leader as the 'bestowed of life'.

The hyo that the theory of captain leader and the theory of social political life contain is manifested from the fact that an explanation of hyo and captain leader creates a problem. Concerning this problem, Jung Il Kim said that children should not honor their parents because their parents have more ability than other parents and not because of taking something interesting from their parents but because their parents are their bestowals of life. Likewise the man who keeps revolutionary loyalty constantly makes a commitment to the captain leader, party and people and follows them by devoting his life because he is thankful for receiving social-political life from the captain leader and the party.²²

Jung Il Kim said again if one is disappointed and betrays his country and saves only his life when his country is under development or in crisis, he is guilty and everybody will scorn his unconscientiously behavior.

The hyo contents of Juche Ideology might be rooted in Confucianism.²³ The idea of absolute obedience to the captain leader has been stressed as the best moral norm since 1990 when the problem of the transmission of heredity was critical and functions to justify Kim's transmission by heredity and to construct individual adoration of him.

2) Hyo presented in theory of the great socialist family and the theory of revolutionary morality

"Labor Newspaper" published in North Korea said the North Korean people had to live in the great family that was not introduced by history until now and was a new human society. And it said the North Korean people were happy to live in this family honoring the great father Jung Il Kim.²⁴

The theory of the great family asserts that the real parent is the captain leader in the great family. Why is Il Sung Kim the real father? Because Il Sung Kim recovered the right of country and allowed the North Korean people to be the master instead of the slave.²⁵

The Traditional Morality of Totalitarianism

Jung Il Kim emphasized children who honored the father Il Sung Kim had a duty and a disposition of revolutionary warriors. As Jung Il Kim said, hyoja-the devoted son/daughter- commits his loyalty to the captain leader as a father to keep his commands and to help achieve his political agenda.

In this meaning Hyoja the great family must follow the father-captain leader's commands, protect the father's well-being, and give pleasure or contentment to father. This is theory of hyoja of Jung Il Kim.

On the other hand, hyo immanent in the rule of ideology of North Korea is stressed as an absolute moral virtue to control North Korea people. This virtue is the revolutionary morality. The basic element of this revolutionary morality is hyo that produces obedience to the father-captain leader.

Now in North Korea hyo is the issue that is a key to the life of the revolution and is a fundamental value to achieve the task of the labor’s revolution.

Jung Il Kim presents himself the incarnation of hyo. As a model he shows his hyo to his father Il Sung Kim so that the North Korean people might honor him as he honors his father Il Sung Kim.

Jung Il Kim's propagandizing himself called this incarnation of hyo was at peak in 1994 when Il Sung Kim was dead. At this time Jung Il Kim kept a so called '3 years mourning' along with the custom of Confucianism. The politics of this term is known as the governing of the teachings of the departed.

By doing this, Jung Il Kim internalized hyo into the mind of North Korea people by promoting socialization as the best virtue among the social norms and as the highest instructional morality to achieve conduct of revolution

2. The criticism of Juche Ideology by HSGP

When we analyze and criticize the Juche Ideology by the HSGP, we concentrate on four points. What are these points?

First, the Juche Ideology as a theory of family that equates a state with family is an extremely simple conceptual structure and it should receive much more criticism.

According to the four variables of the HSGP, hyo of Juche Ideology takes into consideration the 'obedience variable', 'the persistence variable' and the 'agency variable' of the HSGP.

But the hyo of Juche Ideology is much too centered on the obedience variable of the HSGP. In other words the four components of Juche Ideology-the theory of social and

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26 Jung Il Kim, Anthology 11, 303.
27 Ibid., 394.
30 Jucheol Yi, Read Jung Il Kim's Idea(Seoul: Gongjakso Knowledge, 1992), 55.
political life, the theory of revolutionary morality, the theory of the great socialist family and the theory of revolutionary leader mostly emphasize the 'hyo of obedience', Why do they emphasize the hyo of obedience? As Jang Youp Hwang said,\(^3\) to integrate the North Korean people as a political community, Juche Ideology believes it is important to internalize spirits of obedience towards the captain leader. Therefore Juche Ideology emphasizes unconditional obedience towards the captain leader. This obedience, as professor Young Bae Song acknowledges,\(^2\) is from the dynasty of the Jeoseon of Korea history whose system was Confucian feudalism. In this way the North Korean people obey Jung Il Kim as the people of the Jeoseon dynasty obeyed their king.

Second, in relation with hyo of obedience, Juche Ideology utilizes well another element of HSGP: Persistence of hyo. Juche Ideology emphasizes the subsistence of the great family in which the father-captain leader is the center of this great family. The North Korea people give their sacrifice to this great family and the father-captain leader: Jung Il Kim. Therefore, in Juche Ideology, in order to persistence of this great family, the North Korea people should endure, sacrifice themselves. In all, Juche Ideology is successful to take advantage of persistence of hyo of HSGP.

Third, Juche Ideology utilizes well attorney of hyo of HSGP too. Juche Ideology emphasizes hyo of attorney because the hyo of attorney is based on the norm legitimated by the traditional custom. Therefore attorney hyo emphasizes heteronomy rather than autonomy. In this meaning, Juche Ideology puts value on unconditional acceptance rather than individual reasoning about hyo of hyoja.

Fourth, in this way even if there is much more emphasis on obedience, subsistence and attorney, this emphasis might disdain the variable of friendship in the HSGP. According to the HSGP, the relationship between parents and children has both vertical and horizontal characteristics. In other words, 'obedience' and 'friendship' are needed together in the HSGP. So the children of hyo not only obey their parents but also love their parents with a friendship relationship.

But Juche Ideology almost completely neglects the hyo of friendship. Why is the hyo of friendship neglected? The reason is that the regime of Kim’s is totalitarian. In this regime authorities disdain the rights of the North Korean people. Therefore it neglects the rights of the North Korean people as children of the captain leader.

As Easton said,\(^3\) to integrate a system for survival, every political system not only requires the support of the political community but it must also dispose their demands. Therefore if a political system does not balance the two factors ‘support and demand’, the political system faces a critical situation. The hyo system of Juche Ideology that leans excessively upon obedience gives rise to criticism of the North Korean political system.

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\(^2\) Youngbae Song, *Confucian Tradition and Revolution, China* (Seoul: Present and Philosophy, 1992), 460.

CONCLUSION

Now Jung Il Kim's regime is barely surviving owing to the decline of economy. This survival is due to the Juche Ideology that might integrate the North Korean people, especially the hyo of strong obedience in Juche Ideology which has the capacity to integrate the North Korean people.

But in change of international situation the oppression of obedience by hyo of feudal Confucianism in Juche Ideology does not diminish the difficulties of the North Korean situation.

In order to keep the North Korean system through Juche Ideology, the regime needs to make use of hyo of friendship in Juche Ideology. When, by hyo of friendship, the North Korean people's demands are satisfied properly and the regime can invigorate the North Korean people to overcome their difficulties.

If Jung Il Kim properly makes use of the hyo of obedience and the hyo of friendship especially in Juche Ideology, he will succeed in keeping his regime alive and developing the North Korea system together. Therefore the harmony of hyo of obedience and hyo of friendship is necessary for the surviveal of North Korea and Kim's regime.34

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34 It is very important to unify the South and North Korea. And there are many difference strategies about to unify two regimes. But more important thing is unification not through war but through peace. Although there is possibility of a sudden unification according to situation through war, the unification through gradual changing of the North Korea is more necessary than through a sudden breakdown of the North Korea regime by internal or external war.


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“YOU ARE ADAPTING MORE TO ME THAN I AM ADAPTING TO YOU”
(BUT WHAT DOES MORE MEAN?): CYBERNETIC AND FOUCAULTIAN
EXPLORATIONS OF THE DOMAIN OF POWER

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ABSTRACT

It is possible to derive a cybernetic approach to what the concept of “power” might mean, an approach which illuminates and critiques both that concept and the relations it is used to describe. Selected quotes from a short article Michel Foucault wrote late in his life, entitled “The Subject and Power,” are juxtaposed with a demonstration that aspects of his view, particularly as he was formulating it in this article, prefigure some elements of what might be developed into a cybernetic approach to what might be meant by “power.” I propose that such an approach can be developed from basic cybernetic and systems principles including system capacity, (structural) coupling, the relationship of an organism to a niche or environment, and the hierarchical organization of adaptive systems. A resulting concept of power, or rather, of the domain in which we talk about power, can help reanimate our theoretical discussion of what we mean by such a concept and what such a concept inevitably obscures.

Keywords: adaptive systems; hierarchy theory; structural coupling

CYBERNETICS, POWER, FOUCAULT

What follows is an attempt to derive from cybernetics a way to be precise when we talk about power over others, whether that power is exercised by individual human beings over others, by institutions over individuals or over other institutions, or even by animals over their conspecifics. This discourse will both be an explication of the concept of power and a critique of it.

I am not claiming here that power is a universal, necessary, or inevitable concept. It is often difficult to use powerful folk concepts, such as power itself, in a way which adds to precision and understanding. If people were to choose not to use the concept of power, my reaction would be, more power to them. Indeed, if the concept of power did not exist, I am not sure we would have had to invent it.

“The Subject and Power”

I use as a counterpoint to my cybernetic exposition, excerpts from the argument in Michel Foucault’s article, “The Subject and Power.” Foucault is possibly the thinker most identified with the concept of “power” as it is used as an explanatory principle today in the “soft” social sciences.
I am not alone in seeing a kinship between Foucault and cybernetic ideas. The sociologist Céline Lafontaine claims that, “depoliticized, decentralized, and totalized, the concept of power as developed by Foucault is strangely similar to cybernetic control.” (Lafontaine 2007: 36) She also claims that “Foucault relies on the purely relational logic of the cybernetic model.”

However, the reason I am specifically focusing on Foucault’s article, “The Subject and Power,” is because this article, written late in his life, puts forth a version of power which is relational but not in my opinion totalistic, and not coterminous with the idea of control. Actually these are reasons why this particular version of Foucault’s view of power, one which paradoxically does much to deconstruct conceptually both the subject and power, fits with what I propose as an emerging cybernetic concept of power’s domain.

My own ideas about how cybernetics can inform a concept of power are set forth, in the context of Gregory Bateson’s questioning of the concept, in an article entitled “Breaking the Concept of Power (and Redescribing its Domain): Batesonian and Autopoietic Perspectives.” (Guddemi 2006)

In a section of his paper, “The Subject and Power,” entitled “How is Power Exercised,” Foucault rather surprisingly, given his reputation as a theorist of “power”, makes the following remark: “To put it bluntly, I would say that to begin the analysis with a ‘how’ is to suggest that power as such does not exist. At the very least it is to ask oneself what contents one has in mind when using this all-embracing and reifying term...” (Foucault 1982: 424)

**Power-to and power-over**

In contemporary social movements it is common to distinguish two aspects of power, power-to and power-over. Power-to refers to the subject’s capacities in general or vis-à-vis her environment, while power-over refers to the subject’s capacities relative to (and in relation to) other subjects like herself (who of course constitute part of her environment).

- In cybernetic analysis, the capacities of a system refer to the different adaptive responses it is able to make in the face of environmental perturbations. All systems which persist, particularly living systems, maintain themselves in the face of change. Some systems exhibit a greater range of behaviors than others. Learning (and in the very long run, Darwinian evolution) enables a system to develop appropriate responses which had not been part of the system’s repertoire.

- The enhancement of the system’s repertoire vis-à-vis its environment is power-to.

- From Michel Foucault’s article, “The Subject and Power”: “As far as this power is concerned, it is first necessary to distinguish that which is exerted over things and gives the ability to modify, use, consume, or destroy them—a power which stems from aptitudes directly inherent in the body or relayed by external
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instruments. Let us say that here it is a question of ‘capacity.’” (Foucault 1982:424)

• In spite of the phrase “power…exerted over things” what Foucault is referring to here is what is commonly thought of as power-to.

• Foucault, in the quoted section, implies that this kind of power-to is to be distinguished in terms of the type of environment to which it adapts, that is, a nonsocial or in some ways nonliving environment, an environment in which “others” are not present as actors. However, in subsequent discussion he makes it clear that power-to, or power as capacity, is a factor in social interactions or relationships as well. He argues that power as capacity, communication, and what might be called “power proper” can be distinguished analytically but occur in human life as an inseparable “block of capacity-communication-power.” (Foucault 1982:425-6)

• Foucault emphasizes “tool use” as part of the above “power-to” in the quoted section, but in a subsequent paragraph he refers not only to “the field of things” but also to “perfected technique, work, and the transformation of the real.” (Foucault 1982:425) The latter is more in accord with what Bateson (1972) has mentioned as an emphasis of Asian cultures or philosophies, to the effect that new capacities to use “tools” entail changes in the self as well as in the world.

“Power-over” as relational: the cybernetics of its relationality

In this paper we are primarily concerned, on the other hand, with “power-over.” I will begin, here, with Foucault’s exposition:

“On the other hand, what characterizes the power we are analyzing is that it brings into play relations between individuals (or between groups). For let us not deceive ourselves: if we speak of the structures or the mechanisms of power, it is only insofar as we suppose that certain persons exercise power over others. The term ‘power’ designates relationships between partners (and by that I am not thinking of a zero-sum game…).” Foucault 1982:425.

• It is necessary again to think of Foucault’s “individuals” and “groups” in terms of their cybernetic characteristics as systems.

• Individuals and groups which have any sort of “relationship,” to use Foucault’s term, are considered as being “coupled,” to use a term of both W. Ross Ashby and Humberto Maturana.

• “Coupling” can be glossed as “in a relationship which involves recurrent mutual interaction.”
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• To be “coupled” implies separation as well as unity. Each system retains its autonomy, in spite of the emergence of a larger system which includes autonomous systems plus their relationships.

• Ashby here uses first-order cybernetic terminology of inputs and outputs, and refers to the systems as “machines,” in which category he includes organisms. Nevertheless his basic principle stands: “What we want is a way of coupling that does no violence to each machine’s inner working, so that after the coupling each machine is still the same machine that it was before. For this to be so, the coupling must be arranged so that, in principle, each machine affects the other only by affecting its conditions, i.e. by affecting its input. Thus, if the machines are to retain their individual natures after being coupled to form a whole, the coupling must be between the (given) inputs and outputs, other parts being left alone no matter how readily accessible they might be.” (Ashby 1956:49)

• In Bateson’s terms, when we are dealing with living systems, each of them is “collaterally energized.” Each individual animal or human being acts, in its bodily form, based on the energy provided by the food it eats. The mutual causation or feedback between these living systems is thus “informational” in nature rather than being reducible in principle to “matter and energy.”

• Bateson often gave as the example here that “if you kick a stone, the stone will proceed on the basis of the energy provided by the kick. But if you kick a dog, the dog may turn and bite you back, and the energy for the bite will come from the dog’s metabolism not from the impetus you gave by the kick” (see Bateson 1972:229, 1979:112-13). This example is important because it shows that Bateson’s “informational” realm can include the actions of bodies in their very materiality. Batesonian “information” is not a bloodless intellectual realm nor one composed of entirely incorporeal messages/differences.

• (Of course whether one sees the kicking of the dog as power-over rather than power-to importantly depends on how one views the possible agency of the dog; Bateson would have certainly considered the dog’s act as a social one, and would have interpreted the dog’s reaction in that way as well.)

• Ecological relations of predator and prey, for example, participate in “matter and energy” relationships while at the same time demonstrating “coupling” in Ashby’s (and Maturana’s) senses.

• However, human “coupling” or “structural coupling,” in contrast to ecological relations of the predator-prey type, emerges in social living, arising from features of our particular adaptation which require or encourage cooperative action among conspecifics. Maturana and Verden-Zoeller discuss this at length (1996) but I will not do so here, although I am not merely relying on them for this point which I think is supported by considerable work within primatology and anthropology.
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Power, paradoxically or not, depends upon the autonomy of all parties

The coupling of systems which retain a basic autonomy is the basis of power-over, which is therefore not a marionette or robot relationship. Foucault: “Where the determining factors saturate the whole, there is no relationship of power; slavery is not a power relationship when man is in chains. (In this case it is a question of a physical relationship of constraint.)” (Foucault 1982:428.)

- I think slavery is an inferior illustration of this – consider instead the remote control of someone’s brain or muscles by embedded microchips, a classic paranoid delusion which is now technologically feasible.

- Making the inverse point, the previous sentences in Foucault read: “Power is exercised only over free subjects, and only insofar as they are free. By this we mean individual or collective subjects who are faced with a field of possibilities in which several ways of behaving, several reactions and diverse comportments, may be realized.” (Ibid.)

- Foucault also makes the related statement that power is “always a way of acting upon an acting subject or acting subjects by virtue of their acting or being capable of action.” (1982:427)

“Action upon the action of others” defines a cybernetic ecological relationship


- The field of one’s possible actions is one’s niche, or environment.

- When one is structuring the field of another’s actions, one is therefore acting as environment for the other.

- This cannot ever in principle be a purely one way affair.

- Bateson liked to point out that, even in the “controlling” situation in which A desires to control B’s behavior, A must monitor B’s actions and respond accordingly; even Goebbels had to have some reading of German public opinion in order to craft propaganda (Bateson 1972:486). Thus we are dealing with an interactive system in which both sides retain some basic autonomy, or “freedom” as Foucault puts it.
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• This does not make this kind of dictatorial system less than unjust or unequal. It does mean that the system’s analysis must not rely on unicausal versions of “linear” power as control. Foucault’s theory is not of that kind.

• Return to Ashby: “the coupling must be arranged so that, in principle, each machine affects the other only by affecting its conditions, i.e. by affecting its input.” (1956:49 op. cit.)

WHAT MAKES “POWER” INEQUALITY POSSIBLE? A CYBERNETIC EXPLORATION

How, then, does inequality of “power” exist? A cybernetic argument

The internal structure of systems provides the basis for inequalities between systems. The hierarchical structure of adaptation within systems is the building block of any hierarchy of systems.

• Systems that last must be stable enough to last. In dynamic systems, some “variables” will change so that others can remain the same. Some “variables” are more “fundamental” to the system remaining itself than are others.

• Bateson famously analogized the problems of an adapting being to a “man on a high wire,” conserving the truth of the proposition that the man still remained on the wire, but only able to do this by changing the position of arms, legs, torso and so on. (See Bateson 1972:498)

• The Maslow hierarchies of need provide an example of some “needs” being more fundamental than others. In maintaining one’s bodily identity as an autonomous, autopoietic being, certain bodily variables must be maintained within certain limits, must only act within certain constraints. Similarly, in maintaining one’s social identity within a particular society, one must act within certain social constraints, and so on throughout the realm of human being and action.

• In maintaining these fundamental aspects of identity, in “keeping body and soul together,” human beings may use a variety of innate or learned capacities (powers-to) or they may forego using them.

• Couplings can be unequal when they involve one party whose more fundamental processes are at stake, coupling with another party for whom that coupling places only more peripheral and “optional” processes at stake. I am referring to processes or capacities which are less, or more, fundamental to the maintenance of the autopoiesis of the larger system. For example, if the actions of A in relationship to B affect the abilities of B to maintain autopoiesis by meeting her “needs,” more than the actions of B affect the abilities of A to meet his “needs,” then we have an unequal coupling, or a “power relationship.”
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• It is probably impossible to organize an ecology or social system in which no inequalities of this kind exist.

• However, human societies vary in the extent to which they grant legitimacy to such inequalities.

• “Power relationships” are not always characterized by simple inequality between such an A and B considered as individuals or particular systems. They can evince inequality in one realm or aspect of behavior or practice, “balanced” by other inequalities in other realms or aspects.

• This balancing, of course, is not necessarily an “equal” one in its various respects.

A restatement of the relationship between structural coupling and “power”

I have tried to show that the difference between the depth of adaptation of A to B, as against that of B to A, is a function of the particular, specific coupling they have.

• Imagine a change in the structural coupling between A and B.

• If this change requires A to make greater compensating changes to maintain A’s autopoiesis, than B is required to make to maintain B’s autopoiesis, then we have this change instantiating or illustrating a difference in “power,” in which B is seen as having “more power” within the relationship than A.

• This is also sometimes expressed as B having “power over” A.

• But this does not mean that B has control over A, in any full or robust sense of control. B is not causing A’s actions in detail.

• One party makes greater compensating changes because (or actually, insofar as) the coupling affects/ involves that party’s structure (in a more or less Maturanan definition of “structure”) in more profound or consequential ways than it affects the other’s.

• Consider the “free contract” between employer and employee. What is at stake for the employee may be fundamental to her autopoiesis – often enough, her survival. What is at stake for the employer, as a system, in any particular employment decision, is usually far less consequential to the continued autonomous existence of the organization. The employee will make greater compensating changes in her own behavior and practice, these constituting her “adaptation” to the organization, than does the organization to accommodate or adapt to the new employee. Thus this “free contract” is an excellent example of the kind of structural coupling which can be seen as a power relationship.
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• This example is not materially changed if the employer is an individual rather than an organization.

A is adapting to B more than B is adapting to A – a summarizing ecological metaphor for “power,” but what does “more” mean?

Mutual adaptation of A to B and of B to A is an obvious outcome, or restatement, of the surprisingly neglected fact that A and B serve as environment, or “niche,” to each other. It is astonishing how much the concept of “environment” carries the image, or connotation, of being relatively static, even inorganic, like rocks and rain. In fact, dynamic systems – including organisms, including human beings -- exist in each other’s environments, so that each must be seen not only as actor but also as environment to other actors.

The organism – environment relationship is more obviously qualitative than quantitative. Mutual adaptation, when cyberneticians have looked at it, has been seen as a fact yielding a kind of moral imperative, that we recognize the mutual interdependence that involves and implicates us in wider systems.

• Yet we have to recognize that sometimes this interdependence is more painful or difficult or limiting for some beings/creatures/systems/people than for others.

• Can we quantify this difference in pain/limitation/arduousness? (Or should we even try?)

• The metric by which one would make a quantification of relative adaptation to the other – or even a conventional quantification of relative advantage – is actually somewhat obscure. The “what does more mean?” of the title is a real question, and one which deserves significant attention.

• The general statement “A is adapting more to B than B to A” is often true relative to a particular context or situation, rather than as a globalizing summary of their “total” relationship. In fact, globalized evaluations of relative “power” may fail to illuminate particular contexts or circumstances in which the parties are involved.

“Power” is one possible mode of analysis, not an inevitable one

Rather astonishingly, in view of the subsequent history of American academic uses of his works, Foucault writes: “The exercise of power is not simply a relationship between partners, individual or collective; it is a way in which certain actions modify others. Which is to say, of course, that something called Power, with or without a capital letter, which is assumed to exist universally in a concentrated or diffused form, does not exist.” (1982:426)
This may or may not provide an opportunity, or excuse, for asking, what does the concept of power, even a cybernetic one, obscure?

- The expression “B has power over A” obscures the emergent systemic interdependent relationship of the two.

- “B has more power within the power relationship including A and B” is a slightly (if subtly) better phrasing, one which is less likely to obscure their relationality and the system which emerges from it. However even such a phrasing can, and has, been used to imply that the relationship is composed of, and is fully decomposable into, “something called Power, with or without a capital letter, which is assumed to exist universally in a concentrated or diffused form.”

- Nevertheless, the power aspect of relationships – their inequality of adaptation as defined here -- does not fully describe or explain them in all their dimensions, but only in one dimension relevant to particular modes of description and action, and not others.

- It is the tendency to subsume other aspects of relationship into power that has prompted much criticism of the concept, especially by Bateson (e.g.1979:240-48) and others.

**NOT FROM FOUCAULT BUT FROM HOBBES: IS POWER A MOTIVATION?**

The philosopher Mary Midgley quotes from Hobbes:

“So that in the first place, I put for a general inclination of all Mankind, a perpetual and restless desire for power after power, that ceaseth only in Death. Hobbes, Leviathan, Pt. 1, chap. 11.

However, in a cybernetically informed view, it is not necessary to see power itself as a motivation, or a cause.

- The desire to have more “power-to” can perhaps motivate: the desire to have more adaptive options in a particular situation or within a particular life.

- It can sometimes seem desirable to control the behavior of others in order to achieve a goal of one’s own. The control of others is not the goal but a means to it.

- This control may be so that the other is made to facilitate the achievement of one’s goal.

- Or this control may be such that the other is made no longer to be an obstacle to the achievement of one’s goal.
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• What we call the “wielding” of power is A’s strategic use of the “power inequality” between A and B, to limit the choices that B makes within the constraints of the relationship between A and B. In Foucault’s terms this is “structuring the possible field of action of others.”

• But if A limits B’s choices to those pre-approved by A, A forecloses to some extent the possibility of B’s creative adaptation to B’s environment – which may in a wider sense be the environment which A and B share.

• In some cases this foreclosure of B’s creative response may be to the detriment of A, since A will not have the benefits that could have resulted from B’s independent adaptation to their mutual environment.

• A is still not causing B’s behavior in a direct way, and B is still autonomous; A is “merely” circumscribing B’s environment so that B will be more likely to choose what A wants.

• The ability of A to do this has limits.

Midgley on Hobbes: power as an insurance policy, feeding the anxieties it purports to soothe.

The context in which Midgley quotes Hobbes is one in which she asserts, in her confident way, “Those who really pursue power just for its own sake are neurotics, entangled in confusion by habit and destroying their own lives.” Here is her full quote from Hobbes:

“So that in the first place, I put for a general inclination of all Mankind, a perpetual and restless desire for power after power, that ceaseth only in Death. And the cause of this is not always that a man hopes for a more intensive delight than he has already attained to: or that he cannot be content with a moderate power: but because he cannot assure the power and means to live well, which he hath present, without the acquisition of more.” Hobbes, Leviathan, Pt. 1, chap. 11

She comments, “This puts power in its place as an insurance. But Hobbes still made it central and probably never realized how much this circular psychology limited the value of his political theory.” (Midgley 1978:8)

• The uncertainties of life include the uncertainties of the behavior others will exhibit, behavior which could affect the stability of our own adaptation.

• The desire for “power” is perhaps the desire that one can act so as to minimize the ability of others to challenge one’s own autopoiesis.

• But one’s ability to control others in this way is limited, as per cybernetic theory.
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• But if one does this by adapting to others, by cooperative efforts and by self-control (an interesting term), this may reduce the need to try to control one’s environment by controlling the behaviors of others.

• One’s abilities to follow this path as well – which is perhaps the path evoked in Foucault’s last writings, on “the care of the self,” and which has through history been the recommended path of mystics, monks, stoics, and so forth – may also be limited, as per cybernetic theory.

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Korean Politics and Complex Systems Theory

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ABSTRACT

The political system of Korea is closely linked with the lower-level systems of Korean politics since it has the dynamic system that changes consistently through the interactions of external factors and a slight change in the early conditions of one system can bring about a tremendous change in the entire system. Therefore, it is important to understand Korean politics in this sense. The modern system of Korean politics rather operates on an axis of chaos and disorder than order. A political phenomenon is one that is totally linked with each other rather than having a temporary or isolated nature and its chaotic and dramatic nature is further enhanced in the environment of Korean politics as it gets to the recent times. This phenomenon may be regarded as an expression of systematic characteristics that are derived in the macroscopic procedure that Korean society is seeking stabilization as a complex system.

Therefore in order for us to understand Korean politics, we need to recognize the complex properties linked to the problem of Korean society itself and dynamics of surrounding situation. Korean politics is getting more complex as it gets to recent days. The meaning of complexity can be interpreted in two ways. One is that the ground of Korean politics is getting complex and the other would be that the behavior patterns of political figures that play on the ground have been further complicated as compared to the past.

Keywords: Korean politics, complex systems theory, catastrophe theory, non-linearity, complexity

INTRODUCTION

While the society in the 21st century is expected to be further diversified and decentralized, these diversification and decentralization of our society could be regarded as the least coping measures (logic of self-systemization) to complexity. The society we are living is diversified day by day and the matters in our society are getting complex so that they could not be judged by one standard. In such a world, we should not stay in a biased and simple-minded way of thinking. All the time, we have adhered strictly to a way of thinking that analyzes things by separating them. We have focused on how each part are operating after dividing everything into parts, but we have not responded to the problem how the whole is operating from the parts linked with each other. When handling a problem through the theory of complex systemization, the most important feature of this theory is that "the whole is viewed through one." The society we live consists of various subsystems and social phenomenon is made through the complex interactions of these subsystems. The life itself is created under one complex system and our recognition and behavior also are
complex and systematic. Summarizing the characteristics of complex system, the thinking of complexity theory could be characterized by the thinking patterns described as in the following. First, the complexity theory is based on the nonlinear thinking rather than the linear cause and effect principle. Since a numerous number of systematic components that are interacting in various ways can bring an unpredictable behavior, it is impossible through a deterministic linear thinking. Second, we need to think the whole rather the part. Third, this refers to the relational and interactive thinking rather than the mechanistic thinking like the world view of Newton’s that the world is geared precisely as in a gear wheel of watch. Fourth, thinking should be made while considering that a phenomenon may have discontinuity rather than continuity. Fifth, this refers to recognizing objects and events through integration rather than reduction. Various attempts have been actively made to apply the theory of complex system in the contemporary politics, economy and business administration. This theory has been applied in the field of business administration through the fractal management technique and in the field of politics from the studies of understanding political psychology and applying them in the political fluctuations and international relations. Hence, the analysis direction of Korean politics should be shifted to anew paradigm rather than analyzing the political/social phenomenon on the basis of Newtonistic deterministic thinking (such as blood relation, regional relation and academic relation). It is the point that we have to analyze political phenomenon beyond deterministic thinking.

**CASE OF NON-LINEARITY IN KOREAN POLITICS**

The mathematician Godel’s theorem that "the truth or falsehood of a mathematical subject may not be determined without moving to another field beyond the field of mathematics" can be exchanged with a hypothetical proposition that "in order to understand well about Korean politics, we need to jump out to the outside of politics and the conventional paradigm should be changed." While the irregularity and complexity that are commonly observed in the natural phenomenon were remained as a phenomenon that could not be understood well despite of a long period of efforts, the efforts seeking for the regularity or order hidden within the irregularity and complexity based on the chaos theory are made actively in recent years. Likewise, the irregularities and complexities that could not be explained well with past theories have appeared recently in the Korean politics and hence, it is urgent to study them through the theory of complex system. Even in case of Japan, they are actively practicing the policy establishment based on the complexity theory when establishing a national policy. We also have come to a political climate that can apply the theory of complex system to the political phenomenon as new paradigm. If we try to find the examples corresponding to "extermination of dinosaurs" in Korean politics, there would be many cases and the so-called "Bukpoong" can be regarded as one example. Prior to the government of Daejung Kim in 1998, the governing party had used the militarism of North Korea as a deterministic variable for the victory of presidential campaign. However, the result of opinion survey told that the submarine cases of North Korea occurred twice in July of 1998 did not influence much on a special election in the Gangwon province. Prior to that, the governing party had used the belligerent attitude of North Korea that occurs prior to elections by connecting the
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The conservative/stable attitude of eligible voters intentionally or spontaneously to make them acting favorably for the election. However in the special election of filling a vacancy in 1988, the "Bukpoong" deployed under an assumption that "the belligerent attitude of North Korea may work advantageously to the governing party by stimulating the stability mentality of eligible voters" had not appeared as being connected linearly to the logic. The "Bukpoong" logic has disappeared like the case of dinosaur extermination while spinning around the methods used by past governments as the so-called "Sunshine Policy" of Kim Daejung government appears.

Also under the control system of IMF, South Korea even in the politics was influenced by foreign investors. The power of international investors like George Soros has accelerated the political reformation and structural reorganization of Korea as well as the economic system. The president Daejung Kim, in order to raise confidence of the international investors like George Soros, has run the reformation of domestic political and economical systems powerfully. The president Daejung Kim in his own house of Ilsan, immediately after winning the presidential election, has met Michel Camdessus the head of International Monetary Fund (IMF), George Soros the President of Quantum Fund, Sanford I. Weill the President of US Traveler’s Group, and Lawrence Summers the Deputy Secretary of the Treasury. Then, he has met David Lipton a deputy secretary, James Hamon the President of the Export-Import Bank of US, and Alwaleed bin Talel bin Abdulaziz Alsaud a Saudi Arabian prince and billionaire. Daejung Kim the successful candidate of presidential election in Korea together with the activities of stabilizing the investment mind of major foreign figures has tried hard to draw social consent while appealing to reform the Tripartite Commission of labor, business and government and pain sharing in order to improve the international credibility of Korea. In other words, he has tried hard to drive reformation of domestic politics and economy and political stabilization in order to raise the international credibility of Korea.

The betting on investment in Korea and investment amount, which were made through the "Enter" keys of computers in relation to the funds and securities companies located in New York, has brought a wind of reform like a tornado in the politics of Korea by flying over to Korea like a butterfly. And, one unwise word of leader can make the national economy running up to a catastrophe like striking a match. The world finance market is governed by the dynamics of chaos. One trivial word or behavior made by a president of central bank in US or Germany can lead to a crash in the stock price of New York Stock Exchange (NYSE), drawing the simultaneous crash in the world finance market. Thereby, this can make a tremendous impact on the politics of one nation. Consequently, the political system of Korea is closely linked with the lower-level systems of Korean politics since it has the dynamic system that changes consistently through the interactions of external factors and a slight change in the early conditions of one system can bring about a tremendous change in the entire system. Therefore, it is important to understand Korean politics in this sense.

APPLICATION OF CATASTROPHE THEORY TO KOREAN POLITICS

The modern system of Korean politics rather operates on an axis of chaos and disorder than order. A political phenomenon is one that is totally linked with each other rather than having a temporary or isolated nature and its chaotic and dramatic
nature is further enhanced in the environment of Korean politics as it gets to the recent times. This phenomenon may be regarded as an expression of systematic characteristics that are derived in the macroscopic procedure that Korean society is seeking stabilization as a complex system. Therefore in order for us to understand Korean politics, we need to recognize the complex properties linked to the problem of Korean society itself and dynamics of surrounding situation.

When looking through the catastrophe theory, the catastrophic crisis in Korea had the characteristics as in the following. The concept of total crisis in Korean society has been used since the government of Taewoo Noh and this concept has reached to its peak under the control of IMF system. However, Korean crisis is complexly linked in the overall perspective rather than only the side of economy and this is the crisis that has started from the ignorance, obstinacy and surrounding situation of politicians and policy makers. The symptoms of crisis have occurred abruptly since the government of Taewoo Noh and also, they were magnified and worsened gradually. A specific part has temporally raised a functional disorder and at the beginning, they did not make a considerable influence over the entire system. As they exceeded a certain limit, Korea has faced a serious crisis situation.

The stabilization of democratization Since the Declarations on the 29th of June at the end of Doohwan Jeon’s Government has become the driving power of promoting many reformations as it continues up until the government of Youngsam Kim. However in the un-systemized state, the tendency of democratization and commercialization in the slow speed of politics and economy has acted as the fundamental cause of crisis in Korean society since the reformation was made on people rather than on the systemization of Korean society under one principle. Therefore, the efficiency and legitimacy of the system has started to crash; leaders did not know in which direction the highly diversified and information-oriented world was moving; and, they could not establish a countermeasure. In this situation, symptoms of the crisis has been exposed everywhere and Korean society has come to a moment just before a catastrophe as the symptoms of financial crisis are amplified and worsened. Especially due to the imprudent negligence of Hanbo Corruption Case and financial failure of Kia Motors, large companies had failed in a chain but the government did not know what to do about them. Loss of credibility in Korean economy that was derived from these ultimately led Korea to be under the "IMF control system."

As the result, they have appeared to be a fall in the efficiency and legitimacy of political system. Therefore, the crisis of Korea has not occurred due to the cozy relations between politics and business, high-cost and low-efficiency structure, labor dispute and extravagancy, but more attention should be made on the fact that the government did not have the awareness and capability to cope with the sudden changes of internal/external situation. Looking at the fact that the relief loan of IMF was made due by a pressure of US rather than by a will of Korean government, we could see that Korean leaders were not aware of crisis symptoms that have been exposed in the internal/external environment within the system. After all, the IMF crisis has appeared from a crisis of catastrophe that the crisis begun in the process of democratization has expanded throughout the society in the state not having overcome the crisis.
Korean Politics and Complex Systems Theory

INCREASE OF COMPLEXITY IN KOREAN POLITICS

Korean politics is getting more complex as it gets to recent days. The meaning of complexity can be interpreted in two ways. One is that the ground of Korean politics is getting complex and the other would be that the behavior patterns of political figures that play on the ground have been further complicated as compared to the past. The former, as the phenomenon appearing as population grows and society is highly developed, refers to the Korean society moving into the "living system evolved further" if borrowing an expression from the living system. The latter refers to holding a more complex network as compared to the past in the process of building communication in order to survive from the fluctuations of complex society. Therefore, Korean people try to have communication coalition with each other against sudden social fluctuations. Korean politics in comparison to the past has also become more urgent to understand the competition relationship between fluctuation and communication in this perspective.

In this highly information-based society as the world becomes complex and uncertain from the complex functions and problems interlinked to politics, society, economy, foreign policy and military affairs, we have to find a way to survive in this complicated and uncertain world. To do so, it is important to discover cause of complexity and uncertainty and new sciences like chaos, self-organization, complexity, dissipative structure, and new thoughts of evolution may provide a meaningful result in discovering these causes. In other words, we need to consider and settle politics as an unstable complex adaptation system. All the accidents and problems occurring in Korean society are not those that hold a temporary or isolated nature and they are complex subjects that are generally linked one by one, hence getting influence from a dynamic change in the surrounding environment.

For example as the relations between North Korea and South Korea and changes in the international situation are rapidly developed, it is not certain in which direction they move. And as the interests of surrounding powerful countries change multi-dimensionally according to the time and place and they are entangled, we have to establish the policies against North Korea and surrounding countries under a frame of complex system. Especially after the cold war age, international relations were getting extremely complicated. Recently, the successive summit meetings of big powers around the Korean Peninsula show the reality of international relations that have been fundamentally changed after the cold war age. Under a confrontation structure of the cold war age in the past, the strength of tension was high, but the demarcation of international relations was clear and accurate and the diplomatic relations was also simple. However after the cold war age, countries could not cope with the changing international relations with the behavior and attitude of the past. Accordingly in the diplomatic relations of South Korea, we shall have to manage the goal awareness and strategy of foreign policy and the complexity of diplomatic environment.

KOREAN POLITICAL SYSTEM AS A COMPLEX ADAPTATION SYSTEM

Politics is a social ability that is responsible to find a balance under chaos that is an "edge of chaos." The "edge of chaos" is a clue that can solve the political problem itself and Korean society may not escape from a disorder if politics gives up the ability.

It is considered as reasonable to analyze Korean politics with the complex adaptation
system theory. For example, the political coalition made by one party with another party to acquire the political power can be regarded as an effort to obtain competitive advantage in one hand from the parties of not having a coalition and on the other hand it can be a strategic adaptation to acquire the political power. Accordingly, the profit outcomes of power acquisition by one party are determined by the interactions (and their strategies) with the other party. On the other hand, the ability that can change the behavior of the other party along with the time shows an adaptive behavior. Even the struggles to have political coalitions within one party in order to determine strategic agendas could be regarded as one complex adaptation system.

After all, the national phenomena such as stream of complex international politics in the North East Asia that South Korea is facing with, delicate trouble and reunification issue between North Korea and South Korea, political/social conflict, and various policy failures and market failures may be diagnosed and treated through an analysis of complex system theory.

REFERENCES

A SYSTEMS-THEORETICAL REPRESENTATION OF TECHNOLOGIES AND THEIR CONNECTIONS

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ABSTRACT
This paper proposes a systems-theoretical representation of technologies. A technology is represented as an efficient input-output (I/O) system in the sense of mathematical systems theory, where the I/O system transforms the inputs provided for it through the input channels of it into the outputs, which are outputted from it through the output channels of it. This paper also provides a definition of connections of I/O systems as a way to construct a bigger I/O system from smaller I/O systems. Of course it is not always true that a connection of I/O systems is a technology. It can be verified, however, that a connection of technologies is always a technology. In this paper a mathematical verification of this fact is provided.

Keywords: I/O systems; technologies; connections of technologies

INTRODUCTION
The aim of the research in which this paper is involved is to develop a mathematical method for evaluating technologies, in particular, patents (Razgaitis (1999), Smith and Parr (1994)). As a first step of this research, a systems-theoretical (Mesarovic et al (1974), Mesarovic and Takahara (1975), Mesarovic and Takahara (1989)) representation of technologies will be proposed in this paper. This can be employed for further development of the research: for example, such concepts as ‘networks of technologies,’ ‘fungibility of technologies,’ ‘commercializability of technologies’ and ‘connectability of technologies’ can be mathematically expressed.

In this paper, a technology is represented as an input-output (I/O) system in the sense of mathematical systems theory, where the I/O system transforms the inputs provided for it through the input channels of it into the outputs, which are outputted from it through the output channels of it. It is required for an I/O system to be a technology that the I/O system satisfies that for each input there exists an output such that the input is transformed into the output by the I/O system, and for each output there exists an input such that the I/O system transforms the input into the output.
A Systems-Theoretical Representation of Technologies and their Connections

In this paper, moreover, a definition of the concept of ‘connectability of I/O systems’ will be provided, and a proposition which claims that a connection of technologies satisfies the conditions to be a technology will be verified.

The structure of this paper is as follows: in the next section, Section 2, the mathematical framework for treating I/O systems and their connections will be provided. The definition of technologies will be given in Section 3, and subsequently, the proposition mentioned above will be verified in Section 4. The last section, Section 5, is devoted to the conclusive remarks.

MODELS: I/O SYSTEMS AND THEIR CONNECTIONS

This section gives the mathematical framework employed in this paper. This framework is constructed based on the mathematical systems theory (Mesarovic et al. (1974), Mesarovic and Takahara (1975), Mesarovic and Takahara (1989)).

Let $C$ be the set of all I/O channels. For $c \in C$, $X_c$ is the input set of channel $c$ and $Y_c$ is the output set of channel $c$.

**Definition 1 (The field of I/O systems)** The field $F$ of I/O systems is a tuple $(C, (X_c)_{c \in C}, (Y_c)_{c \in C})$.

That is, the field $F$ of I/O systems consists of the set $C$ of all I/O channels and the input sets $X_c$ and output sets $Y_c$ for all $c \in C$. Within the field $F$ of I/O systems, I/O systems are defined as follows:

**Definition 2 (I/O systems)** An I/O system $t$ is a tuple $(S', I', O', (X'_c)_{c \in I'}, (Y'_c)_{c \in O'})$ such that $S' \subseteq X' \times Y'$, where $X' = \Pi_{c \in I'} X'_c$ and $Y' = \Pi_{c \in O'} Y'_c$.

For an I/O system $t$, $I' \subseteq C$ is the set of all input channels of $t$ and $O' \subseteq C$ is the set of all output channels of $t$. Moreover, for an I/O system $t$, an input channel $c \in I'$ of $t$ and an output channel $c \in O'$ of $t$, $X'_c$ ($\subseteq X'_c$) is the input set of channel $c$ of $t$ and $Y'_c$ ($\subseteq Y'_c$) is the output set of channel $c$ of $t$.

**Definition 3 (Connectability of I/O systems)** An I/O system $t = (S', I', O', (X'_c)_{c \in I'}, (Y'_c)_{c \in O'})$ is said to connect with an I/O system $u = (S'', I'', O'', (X''_c)_{c \in I''}, (Y''_c)_{c \in O''})$ on $D$, where $\phi \neq D \subseteq C$, if $\phi \neq O' \cap I'' = D$. If an I/O system $t$ connects with an I/O system $u$ on $D$, then an I/O system $v$ is the connection of $t$ and $u$ on $D$, denoted by $tu|_D$, if and only if $v = (S'', I'', O', (X''_c)_{c \in I''}, (Y''_c)_{c \in O''})$ (see Figure 1), where

1. $I'' = I' \cup (I'' \setminus D)$,
2. $O'' = (O' \setminus D) \cup O''$, and
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3. \((x', y') \in S'\) if and only if there exists \(y' \in Y'\) such that \((x'|_I, y') \in S'\), \((y'|_D, x'|_{D\setminus I}) \), \(y'|_{O\setminus D} = y'|_{O\setminus D}\), and \(y'|_{O\setminus D} = y'|_{O\setminus D}\), where \(x'= (x'|_I, x'|_{D\setminus I})\) and \(y'= (y'|_O, y'|_{O\setminus D})\).

Figure I. The connection \(tu|_D\) of \(t\) and \(u\) on \(D\).

TECHNOLOGIES

In this paper, it is required for an I/O system to be a technology that the I/O system is efficient in the sense that for each input there exists at least one output such that the input is transformed into the output by the I/O system, and for each output there exists at least one input such that the I/O system transforms the input into the output. The next is a precise definition of technologies.

**Definition 4 (Technologies)** A technology \(t\) is an I/O system \((S', I', O', (X'_c)_{c \in I'}, (Y'_c)_{c \in O'})\) such that:

1. for all \(x' \in X'\), there exists \(y' \in Y'\) such that \((x', y') \in S'\), and
2. for all \(y' \in Y'\), there exists \(x' \in X'\) such that \((x', y') \in S'\).

Another type of technologies, which satisfy a condition that is weaker than the one that is required for an I/O system to be a technology, can be defined as follows:

**Definition 5 (Weak technologies)** A weak technology \(t\) is an I/O system \((S', I', O', (X'_c)_{c \in I'}, (Y'_c)_{c \in O'})\) such that:

1. for each \(c \in I'\) and each \(x'_c \in X'_c\), there exists \(x'' \in X'\) such that \(x'' = x'_c\) and there exists \(y' \in Y'\) such that \((x', y'') \in S'\), and
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2. for each $c \in O'$ and each $y'_c \in Y'_c$, there exists $y''_c \in Y'$ such that $y''_c = y'_c$ and there exists $x'_c \in X'$ such that $(x'_c, y'_c) \in S'$.

PROPOSITIONS

The first proposition shows that a technology always satisfies the conditions to be a weak technology.

**Proposition 1** If an I/O system $t = (S', I', O', (X'_c)_{c \in I'}, (Y'_c)_{c \in O'})$ is a technology, then $t$ is also a weak technology.

**Proof:** For $c \in I'$ and $x'_c \in X'_c$, one can have $x''_c \in X'$ such that $x''_c = x'_c$, taking $x''_c$ for each $c' \in I'$ such that $c' = c$ arbitrary. Then, there exists $y'_c \in Y'$ such that $(x''_c, y'_c) \in S'$, because $t$ is a technology.

For $c \in O'$ and $y'_c \in Y'_c$, one can have $y''_c \in Y'$ such that $y''_c = y'_c$, taking $y''_c$ for each $c' \in O'$ such that $c' = c$ arbitrary. Then, there exists $x'_c \in X'$ such that $(x'_c, y'_c) \in S'$, because $t$ is a technology.

The next is the main proposition of this paper, which verifies that a connection of technologies is also a technology.

**Proposition 2 (Connection of technologies is a technology)** If an I/O system $v$ is the connection $tu|_D$ of technologies $t$ and $u$ on $D$, then $v$ is a technology.

**Proof:** Take $x^v = (x^v|_I', x^v|_{I' \setminus D}) \in X'$ arbitrary. Then, there exists $z' \in Y'$ such that $(x^v|_I', z') \in S'$, because $t$ is a technology. Moreover, for $(z'|_D, x^v|_{I' \setminus D})$, there exists $z'' \in Y''$ such that $((z''|_D, x^v|_{I' \setminus D})) \in S''$, since $u$ is a technology. Thus, by the definition of the connection $tu|_D$ of $t$ and $u$ on $D$, $y^v = (z''|_{O' \setminus D}, z'') \in S''$ satisfies $(x^v, y^v) \in S''$.

Take $y^v = (y^v|_{O' \setminus D}', y^v|_{O'}) \in Y'$ arbitrary. Then, there exists $z'' \in X''$ such that $(z'', y^v|_{O'}) \in S''$, since $u$ is a technology. Moreover, for $y^v = (y^v|_{O' \setminus D}, z'') \in D$, there exists $z' \in X'$ such that $(z', (y^v|_{O' \setminus D}, z'') \in S'$, because $t$ is a technology. Thus, by the definition of the connection $tu|_D$ of $t$ and $u$ on $D$, $x^v = (z', z''|_{I' \setminus D})$ satisfies that $(x^v, y^v) \in S''$.

CONCLUSIONS

This paper gave a mathematical framework for dealing with technologies. The concepts of technologies and their connections were newly provided, and the fact that a connection of technologies satisfies the conditions to be a technology was verified. The framework constructed in this paper allows us to develop such concepts as ‘networks of technologies,’ ‘fungibility of technologies’ and ‘commercializability of technologies.’
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These concepts contribute to develop a mathematical method for evaluating technologies, in particular, patents (Razgaitis (1999), Smith and Parr (1994)). The next step of this research must be defining these concepts rigorously within the framework newly developed in this paper.

REFERENCES

DIGITAL DEMOCRACY AND CITIZENSHIP AS THE DEMOCRATIC POLITICAL SYSTEMS FOR THE INFORMATION AGE

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ABSTRACT
Representative democracies throughout the world are undergoing major transformations with strong challenges from well-armored citizenry with ICTs. Voter turnout rates have been steady decline since 1960s in the world, while other forms of political participation of citizens, e.g., popular initiatives and recalls, powerful NGOs, and so on, have been increasing. Into what form will our democratic political systems evolve in the information age. There might be many possibilities to redesign the democratic political systems. ‘Digital democracy’ could be one of the strong alternatives for the new political systems. It is composed of two processes: democratic decision making processes and effective administrating processes. It not only resolves some problems of representative democracy, e.g., the failure of representation, but also takes advantage of some traits, e.g. the emphasis on interaction, process and change, etc., that direct democracy and deliberative democracy are believed to have. Technological feasibility, unfortunately, does not necessarily entail political possibility. If we intend to realize the potentialities of digital democracy, we have to solve some problems anticipated in the information age such as political fragmentation and atomization, overloaded information, tyranny of the majority, etc. In order to overcome these problems and, thus, to make full use of the potential of digital democracy, we have to become citizens with self-guiding capacity. In other words, liberalistic perspectives, which stress civic autonomy, seem more appropriate than communitarian perspectives, which stress civic virtues, for democratic citizenship in the information age.

Keywords: digital democracy, political systems, citizenship, representative democracy.

1. INTRODUCTION
Since the 18th century, most of the democratic counties in the world have been adapting the representative democratic systems which originated from the Enlightenment. The representative democratic systems are, now, facing their legitimacy crises from a widely educated citizenry who are employing new communications technologies(ICTs). Voter turnout rates have been steady decline since 1960s in the world, while other forms of political participation of citizens, e.g., popular initiatives and recalls, powerful NGOs, and so on, have been increasing.

According to Easton(1965, 25), it is helpful to interpret political phenomena as constituting an open system, one that must cope with the problems generated by its exposure to influences from the environmental systems. The ICTs, exponentially developed in these days, are, I think, one of the most powerful environmental changes which strongly influence on political systems. Bailey(1994, 230-233) postulates a set of structural variables with the social system as the unit of analysis in his Social Entropy Theory (SET) and suggests six macrovariables: population, space, technology, information, organization and level of living. I think the ICTs make, at least, five macrovariables, except population, dramatically be...
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changed. In these situations, could the existing political systems be maintained as status quo? I doubt the representative democratic systems keep their validity in spite of environmental or macrovariables’ changes in the information age. Then, into what form will our democratic political systems evolve in the future?

As society is computerizing, citizens can use more political information and also have more communication channels that enable them to transmit their ideas to the representatives or fellow citizens. Thus, the control power of citizens over policy-making processes, their public deliberativeness on issues, and political participation and equality are highly getting increased.

It can be, thus, reasonably assumed that the increased civil power in the information society is making citizenship as important factor as political institutions and structure in operating democracy. So if we are to enhance democracy through ICTs, we need to develop new democratic citizenship as well as to reform political institutions and processes. What kind of democratic citizenship, then, do we need to enhance our democracy in the information age? For this context, this study is focused on how to (re)design democratic political systems and democratic citizenship for the information age.

2. DEMOCRATIC THEORIES

At first, I will start my arguments at representative democracy. Although its institutions and practices are various in each country, it has prevailed all over the world since the 18th century. According to Bobbio(1987, 45), it can be defined as follows: collective deliberations, i.e., deliberations that concern the whole community, are taken not directly by its members, but by people elected for this purpose.

The representative democratic systems, however, are confronting strong challenges from well-armored citizenry with new ICTs. We are now in a period where confidence in them has been undergoing profound challenge to their foundation. While most mainstream democratic theorists continue to hale the advancements of representative democracy, many others have recognized its fundamental limitations and are demanding a dramatic change (Woolpert, Slaton, and Schwerin, 1998, 10). As a matter of fact, every representative democratic system in the world seem to be experiencing wider and wider gulfs of alienation between the representatives and the general public. Ordinary citizens fail to see their representatives as either understanding or reflecting their interests. There is a widely articulated sentiment that their representatives are captive of extremely powerful, “special” - as opposed to the general- interests. It is so called “the failure of representation”. According to Sartori, the widening "confidence gap" between citizens and representative governments is an "unprecedented trend in a number of countries, disillusionment and distrust have currently swelled into a crescendo of frustration, anger and, in the end, an outright rejection of politics. In the end, then, we are confronted with a surge of anti-politics, with what we might call the politics of anti-politics” (Sartori, 1994, 145).

On the other hand, Budge (1996) defines direct democracy as, in the abstract, a regime in which the adult citizens as a whole debate and vote on the most important political decisions, and where their vote determines the action to be taken. Applying this very abstract definition to the circumstances of the contemporary democracies, he translates it into the operational requirement that the body of adult citizens discusses and votes authoritatively on most of the
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matters on which, in representative systems, parliament now debates and votes (35). In other words, he emphasizes on the participation of citizens on the processes of decisions making.

Compared representative democracy with direct democracy in the standards of Dahl’s for a democratic process (Dahl, 2000, 37-38), the former is superior to the latter relating enlightened understanding. However, the latter gets more points than the former in the aspects of citizen's effective participation and control of agenda (Cho, 2002). Although it is generally said that the latter has more merits than the former, why has the former been adapted and prevailed in the world since The Enlightenment? Some of the answers are the Newtonian worldview and the technical impossibility (ibid.). But paradigms in natural sciences are changing from Newtonian physics to post-Newtonian physics, i.e., the theory of relativity and quantum theory. In addition, according to Budge (1996), the technical impossibility of direct democracy can be overcome because of the newly developed ICTs. They provide means for extending electronic citizen access to decision-making. Public policy can be discussed and voted upon by everyone linked in an interactive communications net. This destroys the argument that is described as technical impossibility of direct democracy.

Although the representatives should not be allowed to monopolise key decision-making processes, we acknowledge the value of expertise. The representatives have much more enlightened understanding than citizens have on social issues. The new democratic political systems, thus, don’t have to replace what is connected to representative democracy. They should not replace representative democracy but somehow remake it. According to Bobbio, the problem of transition from representative democracy to direct democracy can only be posed in terms of a continuum, where it is difficult to say at which point one finishes and the other begins (Bobbio, 1987, 52-53). This implies that in reality representative and direct democracy are not two alternative systems, in the sense that where there is one there cannot be the other, but they are two systems that can mutually complement each other. We could sum up the situation by saying that in a mature system of democracy both forms of democracy are necessary.

Now, I will discuss another recent strong democratic theory: deliberative democracy. As you can see in the above definitions on representative and direct democracy, the sharpest contrasting point is who is in charge of deciding the policies. In representative democracy system, the political decisions are taken by elected representatives, whereas in direct democracy system, the most important political decisions are made by the adults themselves. It is who deliberates on policies that is the crucial difference between them. Both theories, however, have in common the fact that they emphasize the deliberation on policies.

In this vein, a number of theorists have recently put forth and defended a conception of democracy called deliberative democracy. Their thesis is that democratic decision-making ought to be grounded in a substantial process of public deliberation (Bohman and Rehg, 1997, 243). In other words, deliberative democracy centers on the idea that a strong democracy should regularly create opportunities for people to engage in dialogue and decision making processes with each other and with public officials (Rapoport and Stratton, 2004, 68).

According to deliberative democratic theorists, political equality without deliberation is of no much use, for it amounts to nothing more than power without the opportunity to think about how that power ought to be exercised. Something such as the criterion that Dahl labels
“enlightened understanding” is required in order to have adequate and equal opportunities for discovering and validating a decision. “The ideal speech situation” of Jürgen Habermas is a situation of free and equal discussion, unlimited in its duration, constrained only by the consensus that would be arrived at by the “force of better argument.” In the ideal speech situation, every argument thought to be relevant by anyone would be given as extensive a hearing as anyone wanted. If a conclusion could be reached without any limit to decision-costs by free and equal persons, then that conclusion can be considered the ideally rational one (Fishkin, 1991, 36). In other words, deliberative democratic theorists emphasize on citizens’ interactivities and changes of their preferences by discussing on public issues.

3. DIGITAL DEMOCRACY

There is no one way or right way to develop the new democratic political systems for the information age, because democracy is a complex, dynamic, and multivariate phenomenon. But we could try, on purpose, to (re)design a political system in order to curtail trial and errors. There might be many possibilities to (re)design it. “Digital democracy” that is the effort to enhance democracy using ICTs could be one of the strong alternatives for the new political systems. It is composed of two processes: democratic decision making processes and effective administering processes. It makes it possible for us to aggregate deliberative civic preferences more effectively and improve our administrative abilities and, thus, increases our self-autonomy and free interactive activities. It not only resolves some problems of representative democracy e.g., the failure of representation, but also takes advantage of some traits, e.g., the emphasis on participation, interaction, process and change, etc., that direct democracy and deliberative democracy are believed to have. It can be said that digital democracy is the synthesis of three democratic theories through ICTs.

In digital democracy, government would function in much the same way as before, but the transparency and the efficiency of administration would be highly improved using ICTs. The parliamentary representatives would change into an advisory, investigative and debating committee informing popular discussion and voting. Actually, in the modern information societies, collective decision-making has been dispersed or “relocated” to networks of (semi-) public agencies, (semi-) private organizations, civil society organizations and companies which has led to the emergency of new forms of governance. This has led some to argue that we are moving towards a “post-parliamentary state”, in which the centrality of parliaments has become eroded (Edwards, 2006, 165).

We can take advantage of politicians, parties and the political division of labour just as well in direct as in representative democracy. The parties can function as facilitators for the transformation of citizens’ preferences and opinions into government action and overlapping interactive process of the citizen, like a catalyst in chemical reactions. In digital democracy, decision-making processes and interaction between the citizenry and the representatives can be activated and, thus, they can become more interdependent from each other. Those all processes are achieved with the help of newly developed ICTs.

In digital democracy, political communication would be rapidly changed in its media and its contents. Nothing in politics, especially in a democratic society, is possible without some form of communication. The media establishment has always played a crucial role in the process of political communication, and traditionally this has been through the broadcast metaphor of one messenger communicating with many receivers. Thus, the flow of political
information between the media and the public is usually a one-way process. The Internet, of course, has the potential to change this flow of political information and thus revolutionizes the process of political communication. Anyone with an internet access account, some space on a server, and web page creation software can now become a ‘broadcaster’ with a potential audience in the millions. Further, the Internet can (and does) remove one layer of filtering of political information—the gatekeepers of mainstream media. In the end, one of the truly revolutionary aspects of the Internet is that everyone is a potential broadcaster and participant in the realm of political communication (Hill & Hughes, 1998, 22-23). This means that citizens' public deliberation and the control power of agenda, some of the criteria that Dahl suggests relating a democratic process, can be enhanced through Computer-mediated Communications(CMCs).

On the other hand, the most unique aspect of CMCs is that the people involved cannot see or hear each other (Hill & Hughes, 1998, 23-24). The lack of visual and auditory information attenuates the social cues that govern interpersonal behavior. And people communicating via computers are usually anonymous. Combined, the lack of visual and auditory cues and the protection of anonymity increase the political equality among those who participate in political communication. CMCs also increase the likelihood of a person expressing unpopular ideas. By encouraging outside the mainstream to participate, CMCs encourage creativity and interactivity among people.

Implementation of the following mechanisms would go some way towards the realization of direct public deliberation: virtual public space, online policy proposals, online consultation, public involvement in select committees, online conferences, interactive information, online evaluation. None of the above proposals is designed to replace representative democracy or to alter radically constitutionally established procedures of law making, parliamentary debate or scrutiny of the executive. The objective is to narrow the gap between representative administration and the deliberative input of the represented within a culture of democratic governance.

4. DEMOCRATIC CITIZENSHIP

As mentioned in the above, citizens can use more political information and also have more communication channels in the information age. The control power of citizens over policy-making processes, thus, is highly getting increased. It can be reasonably assumed that the increased civil power is making citizenship as important factor as political institutions and structure in operating digital democracy. So if we are to enhance democracy through ICTs, we need to develop new democratic citizenship as well as to reform political institutions and processes.

Citizens in cyberspace tend to be more individual, to have more pluralistic value systems, not to act on social norms and practices but to act on their own judgments, and to be more sensitive to their own rights. They can relatively easily construct diverse self-identities following their own will owing to anonymity. In addition, cyberspace cannot be effectively controlled by any specific political community. Taking all of those things into account, we can infer that citizens in cyberspace are inclined to behave in individualistic ways. This means that liberalistic perspectives are diffused in the information society whereas communitarianistic perspectives are lessened. Thus, it is reasonable to reshape democratic citizenship on the bases of liberalistic perspectives for digital democracy.
Accordingly, citizens must have civic autonomy in cyberspace which some liberalists, such as W. Kimlicka (1995) and W. A. Galston(1991), emphasize. The new democratic citizenship whose core is civic autonomy, have three elements; knowledge, values and attitudes, and skills. Citizens in cyberspace must know the characteristics of cyberspace, their political rights and social roles, the structure and processes of digital democracy and contemporary social issues. They also must have values and attitudes to reflect and correct their prejudices and opinions, to tolerate opinions different from theirs, to observe “harm principle” which suggests the limit of personal liberty, and to trust fellow citizens. Finally, They must have the skills to seek and interpret information which is needed to solve specific problems, to make reasonable judgments on the base of given information, to communicate effectively with fellow citizens or the representatives, and to participate in political processes. When citizens have these knowledge, values and attitudes, and skills, they could become citizens with self-guiding capacity.

It is the tasks of civic education in the information age to cultivate citizens with self-guiding capacity. Contrary to virtue, self-guiding capacity or civic autonomy cannot be acquired by training or indoctrination. However, we can grow it by repetitive experiences to participate actively in political processes in cyberspace. So it is need to construct a public cyberspace which is designed to make us experience political participation. If we keep on gathering information from it needed to solve our problems, exchanging our ideas with other people on the basis of gathered information, making our opinions according to the exchanged ideas, and participating in decision-making processes in the public cyberspace, we could, then, bring up our civic autonomy or self-guiding capacity. It is critical to the development of democracy that civic education is strongly committed to bring up autonomic citizens in the information age.

5. CONCLUSIONS
Existing representative democracies throughout the world are undergoing major transformations with the advent of information communication technologies (ICTs). Into what form will our democratic political systems evolve in the future? I think, digital democracy could be one of the strong alternatives for the new political systems in the information age. It not only conforms to changing paradigm in natural sciences, but also can resolve some problems of representative and also takes advantage of some traits that direct democracy and deliberative democracy are believed to have. The developed ICTs make it possible for us to have more political information, to communicate our ideas to the representatives or fellow citizens, and to aggregate deliberative civic preferences more effectively. Now, with the help of developed ICTs, we can design a new democratic political system.

Technological feasibility, unfortunately, does not necessarily entail political possibility. The plain fact is that digital democracy is very much a two-edged sword. It could lead either to popular sovereignty or to populist manipulation. It could give voice to the common man and woman, or it could be the vehicle of implementing policies ill-advised that no one is accountable for the consequences. Thus, if we are to realize the potentialities of digital democracy and to solve some problems anticipated in the information age such as political fragmentation and atomization, overloaded information, tyranny of the majority, etc., we need to develop a new democratic citizenship.
Considered the tendency that human is inclined to be individualistic and liberalistic in cyberspace, liberalistic perspectives seem more appropriate for the new democratic citizenship than communitarian perspectives. It is crucial to bring up citizens with self-guiding capacity in order to make full use of the potential of digital democracy. And it could be the tasks of civic education to cultivate citizens with autonomy for the information age.

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USING SYSTEMS THINKING AND SOCIAL NETWORK THEORY TO IMPROVE CHILDREN’S MATHEMATICAL PROBLEM SOLVING SKILLS

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ABSTRACT
The education of young people with mastery of appropriate mathematical skills is crucial to the future prosperity of every country. The gap between rich and poor countries will get wider if young people in underdeveloped countries continue to get a poor mathematical education. This paper presents the initial stages of a systemic effort to improve the mathematical education of young people in a developing nation. Kids, teachers, parents and researchers from quite different socio-economic backgrounds form part of a collaborative learning effort that integrates them using information technology in order to work together to improve their mathematical problem solving skills. Systems methodologies, social network theory, mathematical tests, and qualitative analysis are used to explore how to improve the students’ beliefs and attitudes towards mathematical problem solving, their collaborative work, and their mathematical skills. In this project we are making a difference in the lives of young people by taking advantage of their different socio-economic backgrounds, the different contexts in which they live, and their different languages.

Keywords: Systems thinking, collaborative networks, cooperation, learning, mathematics, problem solving, social network theory.

INTRODUCTION
Young people who live in the world’s economically most developed countries have consistently obtained much better results in the international mathematic tests that have been done during the last two decades. For instance, this has been the case in the recent PISA and TIMSS surveys. The results obtained by Colombia’s children in the 2006 PISA survey reveal that their math, science and reading competencies are much worse than the equivalent competencies of children living in the world’s economically most developed countries (OECD, 2007). In the 2006 math PISA tests, Colombia ranked 53 among 57 countries and in the 1995 TIMSS tests, Colombia ranked next to last among 42 countries.
Systems Thinking and Social Network Theory

The above serves as a background to the project described in the following pages. The present article describes a case of the structuring of a social network of collaborative learning in order to improve the problem solving skills of school students of eight schools in Bogotá. It also analyzes how the structure of the social network that we contributed to integrate affects the beliefs and the attitudes of the students regarding the resolution of math problems, the collaborative work and the use of Internet.

THEORETICAL BACKGROUND

Because the objective of the article is to analyze how the structuring of a virtual network of learning influences in the improvement of the mathematical problems solving skills and in the beliefs and attitudes of students toward the resolution of mathematical problems, the collaborative work and the use of Internet, its necessary to define some concepts related to these issues.

Mathematical Problem Solving

According to the Programme for International Student Assessment (PISA) of the OECD, the resolution of problems refers to:

“… an individual’s capacity to use cognitive processes to confront and resolve real, cross-disciplinary situations where the solution path is not immediately obvious and where the literacy domains or curricular areas that might be applicable are not within a single domain of mathematics, science or reading”. (OECD, 2004, p. 26).

In order to generate the problem solving skills, its necessary for the individual “… understand problems situated in novel and cross-curricular settings, to identify relevant information or constraints, to represent possible alternatives or solution paths, to develop solution strategies, and to solve problems and communicate the solutions” (OECD, 2004, p.3)

A review of literature specialized in this subject allows to identify a number of factors that helps to delimit what we will understand as ‘problems resolution’. These factors include: the existence of a knowledge base; the existence of strategies and the possibility of developing skills to apply them; the role of the control and the supervising that the individuals develop in the attempt to solve a problem; the influence of personal beliefs and attitudes and its regulation and influence on the will of facing and solving a problem; and the use of specific cognitive practices. (see Dossey et al., 2006; Bransford et al., 1999; Mayer, 1985, 1992).

According to Dossey et al. (2006) the resolution of problems includes skills such as problem comprehension, the characterization of problems, its representation, search of solution, reflection on the problem and communication of the problem’s solution. According to Schoenfeld (1985) to solve problems is necessary to use the resources (prior knowledge, mathematical procedures), the heuristics (understanding the problem, defining the strategy, solving the problem, communicating the solution), the control (a constant questioning of whether or not the right direction is being followed and to take decisions accordingly) and the beliefs (affective, attitudinal and emotional resources) (Polya, 1945). According Charles et al. (1987) a fundamental part of the resolution of mathematical problems is the learning of strategies such as drawing figures, solving a simpler problem, making a table, looking for a pattern, making a model of the problem, working backwards.
Systems Thinking and Social Network Theory

In order to acquire these cognitive processes is necessary for the resolution of problems to be a regular and frequent issue in a learning program, thus the student will acknowledge its importance (Charles et al., 1987).

Collaborative learning

In the previous decades, regarding the subject of how the people learn, the researchers have suggested that learning is a social process and that the activities of collaborative learning are essential for students to build their own knowledge (Artzt & Newman, 1997). The interactions between peers enhance the learning because they generate mechanisms such as conflict resolution through disagreements, internalization of explications provided by others, reflexive explication effect because the own understanding is crystallized in the process of explaining to others, positive and negative feedback in the discussions that take place inside the group (Arbaugh & Benbunan-Fich, 2006).

Mathematics learning isn’t strange to social interaction. A big part of mathematics learning is achieved through communication processes in social contexts (Forman, 2003). “Opportunities for students to think about mathematics are often associated with their talking about mathematics with one another and with their teachers” (Silver & Smith, 2002, p.63). Participating in social activities, the students have the opportunity not only of learning mathematical skills and procedures, but also they will be able to explain and justify their own thoughts, discuss their observations and observe models of how to use mathematics efficiently in different problems resolution situations. (Hurme & Järvelä, 2005).

As a consequence, it is necessary to establish how to guarantee the collaborative learning. This type of learning refers to the one carried out in small groups of students that work together as a group to resolve a problem, finish a task or achieve a common objective. Some aspects to be taken in account in collaborative learning are:

- Group size: the smallest group possible so every member will be needed and the largest possible so there will be diversity of ideas and skills. The researchers have proposed 3 to 6 students per group in presentational groups and up to 15 students in virtual groups. (Bordogna & Albano, 2001).
- Time spent together: in order to generate cohesion the group members must share time (Artzt & Newman, 1997).
- The heterogeneity: the groups must be integrated by students with different skills and socio-demographic characteristics (Graham, 2002).
- Communication skills, peer pressure, reciprocity and individual responsibility (Johnson & Johnson, 1999).
- The establishment of regular routines in order to generate cohesion (Graham, 2002).

Computer supported

Learning can be potentiated with different tools. One possibility is to potentiate it with technological networks. In the virtual environments there is the alternative of synchronous or asynchronous systems. The former tend to acquire more consensus and the latter generate more profound and creative analyses (Benbunan-Fich & Hiltz, 1999). Additionally, the design of the virtual environments must be simple, not overloaded with visual images (Hwang et al., 2006).

The use of the computer to support the collaborative learning has some advantages, for example the information is available at anytime and allows participation equity (Graham, 2002), it promotes an open, safe and reliable learning environment that allows equal opportunities for participating regardless of knowledge levels and without the feeling of being ridiculed or scorned (Dewiyanti et al., 2007).
Nevertheless, it also has some disadvantages such as the increase of the anxiety caused by the task in hand, due to low frequency of participation of the other members and the delays in the replies; and the possibility of free-riding (Benbunan-Fich & Hiltz, 1999). In the case of mathematics learning there is another drawback: it’s possible that the infrastructure that supports the collaborative learning doesn’t support the use of symbolic and graphic language (Hurme & Järvelä, 2005; Hwang et al., 2006).

Beliefs, attitudes, and incentives

The beliefs and attitudes that the apprentices have regarding the collaborative learning, the use and the ease of use of the technology as support to this learning (Arbaugh & Benbunan-Fich, 2006), and the development of skills to solve mathematical problems (Schoenfeld, 1985) influence the learning effectiveness. Also, the design of incentives influences the effectiveness of the collaborative learning (Artzt & Newman, 1997; Benbunan-Fich & Hiltz, 1999).

METHODOLOGY

The methodology proposed for the analysis of collaborative learning using virtual networks in order to improve the mathematical problems solving skills includes a structural analysis (social network analysis) of the interactions generated in the network and a qualitative analysis of the message contained in the aforementioned interactions.

Social Network Analysis

The analysis of social networks helps to explore the world of the actors with the resulting social structures derived from the relations established by the actors. In this analysis, the general structure of the network, its groups and the position of the individuals in it serves to penetrate into the social structures that lie beneath the flows of knowledge, information, interchanges, power, learning, among others (Sanz, 2003). Besides, studies have determined that the social networks present emergence aspects (characteristics that come to existence in particular contexts) and history (known relations and shared experiences) (Cho et al., 2005).

Previous investigations (Cho et al., 2005; Daradoumis et al., 2006; Finegold & Cooke, 2006; Hurme et al., 2006; Cho et al., 2007) have studied the influence of certain behavioral patterns of the individuals in the social network related to their performance in learning, attitudes, among others.

The indicators that illustrate this influence can be centrality or cohesion indexes. The centrality indexes are, among others: grade (shows who is more acknowledged by the other actors); betweenness (shows who is playing a linking or intermediary role). The cohesion indexes are, among others: density (shows the evolution of the network’s complexity), geodesic distance (shows the evolution of the minimal distance between nodes), reciprocity (shows the percentage of participant interactions that were reciprocal) and the coefficient of clustering (shows the subgroups and the network’s fragility) (Wasserman & Faust, 1994; Newman, 2003; Sanz, 2003).

Qualitative analysis

Considering that the communication and argumentation issues are now being regarded as central in mathematics learning (Forman, 2003), the qualitative analysis consisted in a review of the nature of the interactions and agreements of the groups (Hurme & Järvelä,
As in previous researches (Finegold & Cooke, 2006), an analysis of the results of pilot surveys about beliefs on mathematical problems resolution and the teamwork was made. The survey had 30 questions about perception toward mathematical problem solving, 10 questions in relation to teamwork, and 5 questions with regard to use of technology. It was applied to the participants before and after the project.

**STUDY CASE**

**Project description**

The Atarraya project consisted in a virtual network of mathematical problems resolution about proportionality. At the beginning, Atarraya was formed by 206 voluntary students of tenth and eleventh grades of seven high schools of Bogotá (5 schools of a low socio-economical stratum and 2 of a high socio-economical stratum), twelve math teachers of these schools and researchers of the Los Andes University Mathematics and Engineering departments. Table 1 shows the socio-demographic characteristics of the participants.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No.</th>
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<tbody>
<tr>
<td>Male</td>
<td>109</td>
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<tr>
<td>Female</td>
<td>97</td>
</tr>
<tr>
<td>Colegio 1 (high socio-economical stratum)</td>
<td>73</td>
</tr>
<tr>
<td>Colegio 2 (low socio-economical stratum)</td>
<td>17</td>
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<tr>
<td>Colegio 3 (low socio-economical stratum)</td>
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<td>Colegio 4 (low socio-economical stratum)</td>
<td>18</td>
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<td>Colegio 5 (low socio-economical stratum)</td>
<td>23</td>
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<tr>
<td>Colegio 6 (low socio-economical stratum)</td>
<td>14</td>
</tr>
<tr>
<td>Colegio 7 (high socio-economical stratum)</td>
<td>44</td>
</tr>
</tbody>
</table>

**Table 1. Characteristics of the participants**

The objective of the network was that the students worked collaboratively in order to solve mathematical problems. For that purpose an application was designed (see figure No. 1) with password restricted access, given to each student of the project. The network was created initially with heterogeneous groups (in terms of schools and gender of their members) of 5 students.

Before beginning the project the students were gathered so they filled out the survey on computer use, teamwork and mathematics learning. Besides, a group dynamic, that required virtual communication, was done. In the end of the project a similar activity was carried out in order to corroborate the possible changes resulting from the process.

The network functioned from September 2006 to November of the same year and from February to May of the following year, with a problem each month (7 problems in total).
The idea was that the students examined each problem and worked both individually and in group, using the group’s forums and chats available for that purpose. Additionally there were general chats and groups (for the interaction of every student of the project) with the purpose of generating a social environment for the entire network. After discussing the resolution of the problem, the students could send a group agreement with the problems solution. The researchers checked the solution and feedback the group, mainly in two ways: encouragement to keep participating in the network and guidelines on some missing or wrong elements in the sent agreement.

At the beginning of the third problem the directive board of one of the schools involved (school No. 7) decided to drop off the project. The decision was made because, at that time, students had many extra class works and activities and needed to concentrate on their projects. On its behalf, the Atarraya project administration decided not to restrict the access to the website to the 44 students of the mentioned school. Therefore, if any student, by personal initiative, wanted to continue in the project, he or she could do it.

On the other hand, many students expressed their difficulties to get access to the Internet and participate actively in the project. These students were members of the 5 public schools, of a socio-economic low-level, with limited access to computer and Internet at the facilities, because the few computers available are used in classroom activities. This became a determinant factor of the low-rate participation.

During the entire project there were periodic (monthly) gatherings with the 12 teachers and two leader students of each school with the purpose of evaluating the structuring process in terms of the projected goal. In an open to dialogue environment, the participation in the virtual network was analyzed and alternatives for encouraging the participation in the network were proposed. Some of the changes proposed in these meetings were:

- Since the participation was entirely voluntary and didn’t generate incentives in the classroom (it wasn’t linked to the class curriculum), there were several stimuli designed throughout the project in order to encourage the participation. The incentives changed throughout the project. The most common were: iPods and movie tickets raffled between the groups that discussed the most about the problem and send agreements.
- Because there were 206 students invited to the project, but only near to 25% of them participated actively, the network was restructured in the middle of the project with two type of groups: the groups formed by students with active participation (8 students per group) and the groups formed by students with very little participation (10 students per group).
- Finally, due to the difficulty to access Internet of the low stratum students, a computer room was made available for 3 hours per week in Los Andes University to facilitate their access to the virtual network.

a)
Figure 1. a) Students menu for the atarraya.uniandes.edu.co website; b) Website for posting messages in the group’s forum

Data

The data gathered, that is the basis of our analysis, is surveys taken by the participants on their attitudes and beliefs regarding the resolution of mathematical problems, the collaborative learning and the use of Internet. Additionally, the interactions of the individuals in the network were examined as well as the content of those interactions. It’s important to stress that our unit of analysis is the individual.

ANALYSIS
In order to achieve the objective of exploring how the network structure affects the mathematical problems resolution skills and the students’ beliefs on this subject, the collaborative work and the use of Internet, two types of analyses were made. The first one consists in a description of the interactions and the agreements developed by the students in one of the 7 problems (“the rice problem”). Linked to that description is the analysis of the surveys on beliefs taken before, during and after the project. The second one consists in a structural analysis of the networks, keeping in mind some cohesion and centrality indexes. Both these analyses lead us to establish a series of correlations between the described variables with the purpose of reflecting on this exploratory study.

**Qualitative analysis**

**Types of participation**

Among the 7 problems proposed to the students during the study time, one that had one of the highest number of interactions, and quality of these, was the one we named “the rice problem”, in which 7 brands were presented with their respective discounts, and the students had to identify which ones had the same discount and which ones were the most and the least attractive for the buyers. In this problem 42 out of the 206 students inscribed in the program participated, that is, the 20,4% performed some type of interaction.

The time granted for “the rice problem” was a month, during which the students had access to the website and its resources, that is, the forum and the chat (the general one and the group one). During the first and the last week the number of interactions was higher than in the rest of the month; the first case is explained by the novelty, the 42 students connected to read the problem and to the discussion sites (forums and chat) to reach an answer with their teammates. However, as time went by and the answers from the rest of the members didn’t arrive the interest decreased until the week in which the agreement had to be posted in the designated website.

Of the 42 people that read the problem, 34 (16,5%) participated actively in the forums (the group ones and the general one). Only 5 groups (of the 24 groups of the network) had members interacting among themselves in the group forum, with an average of 3 members per group interacting (that is, a third part of each group).

Of the interactions, the ones with a higher mathematical content were the ones that took place in the group forums and in the general forum, where each member posted what he or she had accomplished so far, or questions regarding the problem or the group dynamic. Figure No. 2 shows the percentage of communication sorted by the type of interaction that took place in the network forums, from a total of 165 messages.

A social interaction (9%) meant messages to set dates, remind events, among others. A mathematical interaction (49%) meant the discussion about the mathematic issue of the problem (proportionality) and the proposed strategies to solve the problem (representations, relevant data selection, make a model of the problem, among others). An interaction on attitudes (15%) involved commentaries in favor of (or against) the problem, the teamwork or the virtual environment. Finally, we consider “noise” (27%) the messages that didn’t generate any of the aforementioned types of interaction and that we regard as trivial. Table 2 shows an example of the type of interaction developed in the forum.

Of the 49% of mathematical interaction, the 14,3% represents interactions about strategies to solve the problem. Because of the low volume of messages regarding solution strategies for
the problem, the mathematical discussions focused on answering the questions, with little analysis of the procedure used to answer them.

On the other hand, interactions in the chat rooms (both general and group), were social and noise (both categories add up to a 100%). In this case, it seems that the chat rooms generated a social environment in the network.

The 5 groups that managed to interact with an average of 3 members interacting per group, presented agreements with the solution to the problem. However, reviewing those agreements, only one (1) presents the answer in a systematic way, along with the procedures and analyses made to reach the answer.

![Type of communication on forums](image)

**Figure 2. Types of communication in the forums, for the rice problem.**

With this 16.5% of active students some perceptions regarding teamwork and mathematics were reviewed, before and after the project.

**Teamwork**

A very important skill in mathematical problem solving is to work in group. Figure 3 shows that, before initiating the project, 47% of the participant students liked to work in groups.
After the group work done during the months of the project, the students evaluated the teamwork and noticed less difficulty in this type of work and more acknowledgement of the ideas of others. However, increase the distrust toward the proposals of others. This can be seen in the Figure 4. This results are statistically significant with an alpha of 0.05 (for the difficulties to work in a team and mistrust between peers cases) and 0.1 (for the acknowledge of peer’s ideas case).
Ruby, G18, FGrupal: For the first question. The offers that are very alike are options 1 and 3 because in these two options the price is calculated and the 3rd kilo you buy is not paid. Second question. I don't have an accurate answer because the option 6 could be the least appropriate to buy when the rice offers. For question 3 I think it could be the option because the 3rd kilo is free...but look that all offers have a big discount and isn't just that, but for all options is given or analyzed the same to know that in all offers the 3rd kilo is free doesn't matter the brand of rice chosen.

Ruby, G18, FGrupal: have in mind that besides the offers given bye the rice brands... the market also gives an additional 15% discount, then if we buy 2 kilos they wouldn’t charge us $2000 pesos but less because they would compute both discounts (the offer’s and the market’s)

Ruby, G18, FGrupal: here I send you another way to solve of the first item.

Jhon, G18, FGrupal: analyze this and then respond me: 1: I consider the two rice brands with the same discount are rice tigre and rice casanare, even if the offers are different the final discount is the same. 2: The least appealing offer for Jairo and Juanita is the given by rice La rebaja, because both of them want when buying rice the best option is the one to save some money, therefore, the discount given by rice La rebaja is not the best, is the least significant within the offers.3: Arroz del oro 1k=25% 2k=30% 3k=50% 1k= 750(25%) 2k= 700(30%) 3k=500(50%) total=1950 1950-292.5(15%)=1657.5 -- This is the best offers for Jairo and Juanita, first of all, it gives a fear discount per kilo, somehow reasonable, and second, because it gives the buyer the opportunity to save some money when buying a certain product.

Ruby, G18, FGrupal: Hi, I liked very much the fact that someone of our group finally participated.

Jhon, G18, FGrupal: Hi, rubmor, let me know your answers so we can compare and reach some kind of agreement

Jhon, G18, FGrupal: The lack of voting on my agreement is caused by computer failures, for example in mine, I try to download the attachments and they won't open. Regarding my group, I have one connected already. With the calculations I have several doubts: La rebaja offers says: In rice La Rebaja they give a bonus of $200 pesos, and the publicity said: for the first kilo bought, pay with one bonus, for the second give two, and for any additional kilo give two bonus as part of payment” this means: for 3k you give 2 bonus of $200 pesos, or for 2k pay with 2 bonus, and for the 3rd kilo, Which is the additional one (depending on the brand) they give 2 bonus of $200 pesos, regardless the 2 bonus given for the 2 previous kilos? The other doubt is that it isn’t very clear to me the offer of rice el tigre because it says: “Rice tigre offered a discount of 20% on the total of purchase, and on the 2 kilos rice packages it said: Our scale is broken to your favor, our 2 kilos packages are now 2, 5 kilos because I don’t know if the scale is broken giving us extra 0, 5 kilos. The logical thing is to complete de 3 kilos buy other package of 500 gr. (0, 5 kilos), because the 2 kilos package is giving us 1/2 kilo for free. Please respond here or by mail: joffrygomuz16@hotmail.com

Ruby, G18, FGrupal: What’s up guys? Isn’t there any one to help solve the problem? Get wit it!

Table 2. Example of the interactions in the group forum.

The above can be ascribed to several causes. First, during the project the students were more aware of the mathematical issues, thus they were inclined to acknowledge as well as to question the proposals of the other members of the team (Forman, 2003). This kind of interactions generated more acknowledge of peer’s ideas and less difficulties to work with a team.

Second, the fact that the virtual interaction became difficult and that some of them were acquainted because of their schools caused that, in general (with member of the network outside of their own school), distrust was generated, while the interaction with members of
their own school turned out smoothly. This possible cause is united to the fact of the emergence and history of the networks: the existence of pre existent social circles (Cho et al., 2005) affected the creation of new connections and limited the actions between group members; on top of that, the differentiated cultural context broadened gap between the group members.

Third, the participation on the project, as mentioned earlier, was not periodic within the time of each problem, not generating the sufficient cohesion, as no habitual routines were established (Artzt & Newman, 1997; Graham, 2002). As a consequence, more anxiousness was generated because the periods between responds (Benbunan-Fich & Hiltz, 1999). This fact raised the mistrust between peers.

**Beliefs, attitudes about mathematical problem solving**

Another important aspect in mathematical problem solving is what students believe about this issue (Schoenfeld, 1985). As part of the self evaluation that the students made during the learning process they answered a reflection with their attitudes, beliefs and perceptions about the problem comprehension and the establishment of strategies to solve it. This reflection was made for the rice problem and shows how students themselves evaluate their improvement in the skills in problem solving.

The results of that reflection (shown in the Figure 5) show little employment of problems resolution strategies, in spite of their alleged understanding of the problem.

Figure 6, on the other hand, shows the positive perception that the students have on their initial and final state in problems resolution regarding the comprehension of the problem. In other words, comparing the answers before to and the answers after the project, students believe that they have improved their skills to solve mathematical problems. Moreover, an aspect that draws powerfully the attention is the little utility they find in mathematics and, specially, in solving mathematical problems (see results to: I think is useful to solve problem like this). Despite of the Figure 6 shows differences in beliefs before and after the project, the results of significance test show that only the last question (I think is useful to solve problem like this) is significant with an alpha of 0.1.
"The rice problem" Reflections

Figure 5. Reflections on the self evaluation about the learning of problem solving strategies

Comparison of beliefs about problem solving skills before and after the project

Figure 6. Comparison of personal beliefs about problems solving skills before and after the project

Social Networks Analysis
The 206 students of the project interacted for a period of 7 months (with a problem each month). For each problem the interactions established in the forums (the general one and the group ones) by the participants were considered as a social network. The conversation that took place in the chat rooms weren’t taken in consideration because most of them consisted in trivial messages that didn’t generate discussions on mathematical topics.

Each one of the 7 networks established by the students was described through the following cohesion measures: density, clustering coefficient, reciprocity, average distance and compactness. The results of those measures are shown in Table 3.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average density</td>
<td>0.0451</td>
<td>0.0004</td>
<td>0.1095</td>
<td>0.0202</td>
<td>0.012</td>
<td>0.0076</td>
<td>0.0101</td>
</tr>
<tr>
<td>Standard deviation density</td>
<td>0.3369</td>
<td>0.0232</td>
<td>2.6173</td>
<td>0.2754</td>
<td>0.155</td>
<td>0.1192</td>
<td>0.1858</td>
</tr>
<tr>
<td>Clustering coefficient</td>
<td>0.553</td>
<td>0.189</td>
<td>4.439</td>
<td>1.521</td>
<td>0.846</td>
<td>0.888</td>
<td>1.636</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>0.052</td>
<td>0.0</td>
<td>0.2198</td>
<td>0.1549</td>
<td>0.129</td>
<td>0.125</td>
<td>0.1747</td>
</tr>
<tr>
<td>Average distance (among reachable pairs)</td>
<td>2.169</td>
<td>1.278</td>
<td>2.563</td>
<td>2.003</td>
<td>2.222</td>
<td>1.627</td>
<td>1.941</td>
</tr>
<tr>
<td>Compactness (cohesion)</td>
<td>0.072</td>
<td>0.0</td>
<td>0.07</td>
<td>0.022</td>
<td>0.017</td>
<td>0.008</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Table 3. Measures (SNA) of the networks established in the project

Note: problem 4 is the rice problem.

From Table 3 it can be inferred that, in general, the networks established by the students were very fragmented (the cohesion-compactness index is very low in all of them). All the measures are consistent among themselves, though it is important to notice that, despite the low cohesion of the network, in some cases such as in the network of the problems 3, 4 and 7, the interactions were slightly more reciprocal.

It must be taken in account that between the problem 3 and the problem 4 there was a change effectuated in the structure of the network, which consisted in the generation of new work groups with the students that had participated actively in the project and, at the same time, the creation of other groups with the inactive students. This change took place since problem 4, and remained until the last problem. Although the change didn’t affect the cohesion of the network, it generated more reciprocal interactions. It is possible that the generation of reciprocal interactions was improved by the incentives and personal motivation given within the active student on the network (Arbaugh & Benbunan-Fich, 2006). In addition, several students were classmates as well as project group mates, making the existing networks to be more reciprocal (Cho et al., 2005; Hurme et al., 2006).

Additionally, the behavior of each actor in the established network was examined with the centrality measures: grade (in and out) and betweenness. The results of these measures show the following:

- In the networks generated in the problems 1 y 2, there’s no evidence of a distinguishing behavior of the participants. This is the result of high-participation level of the school No.7 in the problem 1, the same that later on drop off the project. Because of that, there are no central actors of that school in the rest of the project. Additionally, in the second problem there were almost no activities on the net.
- In the networks generated in the problems 3, 4, 5, 6 and 7 there are some noticeable behavioral patterns in some participants. Some members became central nodes
inside of the network during these last five problems (such as 120, 101, 154, 1 and 2). Other members become intermediaries (such as 181, 38, 172 and 143).

- These members with central positions in the network have 18% of the messages about mathematical discussions.
- This type of participants generates a network dynamic that provides certain agglomeration and reciprocity.
- The networks, in general, remain stable in its number of participants, even in those that participate actively.

In the Figure 10 we can observe the interactions that took place in the described networks.

a) Problem 1

b) Problem 2

c) Problem 3
Systems Thinking and Social Network Theory

d) Problem 4

e) Problem 5

f) Problem 6
Systems Thinking and Social Network Theory

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Convention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Blue</td>
</tr>
<tr>
<td>Female</td>
<td>Red</td>
</tr>
<tr>
<td>In-degree</td>
<td>Node size</td>
</tr>
<tr>
<td>School 1</td>
<td>Circle</td>
</tr>
<tr>
<td>School 2</td>
<td>Square</td>
</tr>
<tr>
<td>School 3</td>
<td>Upwards triangle</td>
</tr>
<tr>
<td>School 4</td>
<td>Box</td>
</tr>
<tr>
<td>School 5</td>
<td>Downwards triangle</td>
</tr>
<tr>
<td>School 6</td>
<td>Box in circle</td>
</tr>
<tr>
<td>School 7</td>
<td>Diamond</td>
</tr>
<tr>
<td>Number of interactions between nodes</td>
<td>Arch size</td>
</tr>
</tbody>
</table>

Figure 10. Interactions during the entire project of collaborative learning.
Finally, an analysis of correlations was made between the variables of the survey and indexes of the network that were studied in this project. From that analysis the following can be said:

- There is a positive correlation between those factors affecting the work in team and learning of mathematical problem solving skills (0.63). In other words, the students felt that thanks to team work and knowledge exchange within the network they can improve their own skills (Silver & Smith, 2002).
- There is a positive correlation between the level of trust developed within the teams and the reciprocity of the messaging (0.55), and the clustering (0.52). This means, that each the reciprocity and the clustering affect the level of trust. It also means, that the reciprocal communication between peers was even more rich and of higher quality when existing trust.
- The participant in the network central positions affects positively the reciprocity and clustering (0.81). In other words, the main actors of the net (regarding in-degree, betweenness and out-degree) are the links over which the important communication processes of the net (mathematical discussions) are structured (clustering and reciprocity) (Hurme et al., 2006).
- After the network’s structure change, the central positions and the network’s dynamic was related to its history, which is why, starting from problem 4, the network has a positive correlation in terms of participation rate (0.65) and the behavior of the participants in central positions (0.72). This shows the emergency conformation and history of the social networks. In other words, after a certain number of interactions on the social network, there is a strong relation between the prior interactions and the future ones, and the behavior of the participant on the net.
- The participant in the central positions on the net conform the group of student who think in strategies to solve a problem before doing any mathematical operation (0.626).

**FINAL CONSIDERATIONS**

The results of this exploratory study show mainly a positive change in the perception of the students towards collaborative learning in mathematical problems solving and their own attitudes about mathematical problem solving. They also show the important role played by the main actors of the network in the production of that type of collaborative learning, where reciprocity is generated and the teamwork structuring is achieved.

On the other hand, it could be seen that, even though there were 206 students invited to participate, only a small fraction (close to 25%) was willing to do so. Because of this low participation rate, the structuring of a learning network wasn’t entirely possible.

The above leads to a series of considerations:

- First, regardless the active participation of the student is low, it is necessary to have in mind that the project counted on volunteer students. It is possible then, that if we want to create a new collaborative virtual work network, it should be linked to the student’s curriculum, generating even more participation.
- Second, a factor that may have influenced in the motivation of the students to participate was the duration of each problem (a month), that caused that the efforts of the students occurred only in the beginning and in the end of each month (Charles et al., 1987).
- Third, the training of teachers and their continuous accompaniment in process such as the ones described in this article are vital factors for the achievement of the goal proposed in this project.
- Fourth, the difficulty to access Internet of a significant percentage of participants may have also been an important factor of the low participation rate. The lack of appropriate and sufficient equipment within the socio-economic low-level schools was an important variable for the purposes of this work. Although, in virtual learning project more equity...
is achieved (Graham, 2002), it is important to guarantee a minimum of technology requirements to pursue this collaborative virtual learning.

- Fifth, the type of interactions on the net changed depending on the context in which the students interacted in. In the chat the interactions were social. Instead, in the forums the interactions were guided toward the problem solution. This is important, so in the next projects this social process should be considered in the net.

The experience obtained in this project puts forward new challenges related to the obstacles presented in this article. A work derived from the analysis of this project is currently being carried out with elementary school students from one of the participant schools. For this new project, is considered, besides the variables described in this article, the improvement in the problem solving strategies regarding the problem comprehension, solving strategies, process control and communication of the answers (Schoenfeld, 1985). The mentioned project started on October 2007 and in the first two problems developed, it was found an active participation level of 33% within the 75 students of fourth grade of elementary school (a rise near to 8%, comparing it to the project described in this article). This work is taking in account the considerations obtained from this investigation and constitutes the next step in the road to answer the question of how to use collaborative work in a virtual network in order to improve the mathematical problems solving skills.

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EVOLUTIONARY ETHICS:
VISION AND VALUES FOR A WORLD OF INSURMOUNTABLE OPPORTUNITIES

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ABSTRACT

One of the great leaders of Mexico, President Benito Juárez, once said, “El respeto al derecho ajeno es la paz” — respect for other’s rights is peace. Such an understanding of peace carries with it a distinctive intentional connotation, an appreciation of which is necessary for an orderly transition from a materialistic, ego- and nation-state centered world to a global civilization where all can live and thrive in dynamic interdependent coexistence. In fact, an ethic based on concern and respect for all people in the human family, as well as for its life-supporting environment, is a precondition of respect for world peace.

Societies all around the world are currently experiencing a period of rapid and extensive transformation, certain facets of which involve integration toward greater globalization while others involve dissolution toward increased factionalism. In this age of interconnectedness and interrelatedness, the environmental and demographic challenges facing humanity are of equal measure to the opportunities for meeting them. New ways of living in harmony with each other and the planet are emerging – ways that offer a path for all people in the global community to live in dignity and freedom, without destroying each other's chances of livelihood, culture, society and environment. Clearly, action steps are urgently needed to meet the contemporary challenge of change, but the type of action and the ideals that inform it will make the difference between a world of crisis and chaos and one of balance and alignment with nature. An "evolutionary ethic" is the moral and psychological foundation for an orderly transition to a global civilization, just as the structures and provisions of world peace are the relational and sociological foundation for this epochal step. This paper defines the nature of an evolutionary planetary ethic, considers its origins and the chances of its timely spread in contemporary society.

Keywords: Evolution, ethics, development, sustainability, learning society
Vision and Values for a World of Insurmountable Opportunities

**TAKING STOCK**

Even a cursory glance at the impact humankind is having on the life support systems of planet Earth makes patent the unsustainability of contemporary cultures of individualism and self-entitlement. Creating a new culture through an ethic adapted to our time is not a quest of foolish arrogance – it is the survival imperative for sustainable co-existence of humankind with planet Earth. Societies all around the world are currently experiencing a period of rapid and extensive transformation. The signs of change are pervasive, and the rate of change is itself changing and accelerating, speeding contemporary societies toward a critical threshold of stability and engulfing the individual in a confusing blur of behavioral choice. One the one hand we are witnessing global flows of information, energy, trade, and technology swept up in massive economic reforms and political reorientations. On the other, and in no small measure due to the magnitude and intensity of these flows, we are experiencing climatological and ecological maelstroms that are altering the physical essence of our planet. The resulting turbulence of these dynamics creates a disorienting and disrupting vortex of social, cultural, technological, and ecological change on both local and global levels. And yet our evolution, our developmental history as an emerging planetary species, has prepared us to meet the challenge of surviving these crises. The question is whether we will rise to the occasion, and if we do, the extend to which we will barely survive them or find ways of transforming them into opportunities for thriving on this one wild and precious planet we call home.

**CLOSER CONSIDERATION**

Economic and cultural integration in North America and Western Europe; social and political transformation in Eastern Europe, The Middle East, Africa, India, Pakistan, and China; human caused global climate change; declining levels of biodiversity and ecosystem viability; changes in the migration patterns of both human and animal populations — these are not isolated phenomena: they are organic elements in the dominant pattern of our times. Interestingly enough, this pattern also manifests countervailing dynamics, such as social innovations that focus on quality of life and local community initiatives that emphasize self-directed sustainable development on the one hand, and breakthroughs in technologies that promise increased efficiencies and means of harnessing renewable energy sources on the other. Nevertheless, the common feature is the transition that virtually every part of the world is going through. Some of the more visible effects of this transition include indebtedness and financial crisis in the Third World, geo-political and instability associated with international initiatives stemming from the First World, and urban, food, and environmental crises in all three “worlds.”

Are all these changes part of a normal course of societal evolution, or are we in a fundamentally different phase of development as we round out the first decade of a new millennium? I don't think this is normal. Humanity is transiting into a new kind of society, one that is as different from the society we leave behind as the grasslands were from the caves, and the settled villages of antiquity were from life in nomadic tribes. The
society we are leaving is the nationally based industrial society created at the dawn of the first industrial revolution — the society toward which we are heading is an interconnected socio-economic system created by the growing impact of information, the globalization of business and government, and the ever greater demands on an increasingly over-burdened and fragile terrome.

The evolution of far-reaching social structures with powerful technologies has changed the surface of the earth. But such advance has also tended to reinforce social inequities, political stresses, and unreflective uses of technology in ways that polarize humanity and degrade nature, creating problems of global dimension. Global warming, the attenuation of the ozone shield, the menace of deforestation and desertification, the destruction of many species of flora and fauna, the extensive pollution of air, water and soil, and the poisoning of the food chain are threats that all societies now share in common. These are the characteristics of our current problematique — they represent the dangers to be averted and the opportunities to be seized upon in the global transition in which we find ourselves at the dawn of the new millennium. To act in syntony with sustainable evolutionary dynamics, we need to have recourse to a better compass by which to guide societal development.

Ethical inquiry needs to be dedicated to the exploration of evolutionary consciousness from a transdisciplinary perspective. This calls for the intensive and extensive exploration of the evolution of consciousness as the ontological basis upon which to cultivate conscious evolution. As such, the new inquiry needs be both informed by, and in service to, a transcendent evolutionary paradigm (i.e., not one bound by any disciplinarily derived axiology of evolution, nor by any one theoretician or theory of evolution). The objective of such inquiry is to foment the emergence of a meta-evolutionary ethical paradigm, and to cultivate evolutarily informed anticipatry democracy toward the betterment of our collective chances for evolution with distinction — rather than risk unwitting devolution to extinction. The result of such a future oriented, life affirming, opportunity increasing transdisciplinary pragmtism would be an actionable evolutionary ethic; one able to guide human societal change efforts through an evolutionary praxis that places human affairs in the context of planetary sustainability. This is the shape of the ethical compass that is being wrought of Evolutionary Systems Design.

**CONVERSATION AS FUTURE CREATION**

We need not be victims of change, destined for one future or another according to either a predetermined plan or random chaos. Both individually and collectively, we can learn how to have change happen through us, not to us! But we must find out how to look, listen, and learn — to really see and hear and understand the underlying patterns of change so that we can distinguish between those dynamics that are destabilizing and those that forward sustainable futures. The sharp discontinuity between where we — as not the most unobtrusive species on Earth — are going and where we should be going is underscored by the need for new ways of thinking, new ways of learning and new ways of conversing.

As a society, we have to learn better how to learn – I call it social learning; it is the dynamism for change that could lead us to a new kind of society that will not destroy itself from its own excesses… for we must share a vision for a new society before we can realize it. Designing a better society and maintaining a good life require deep thought and sustained effort by all of us. Reasoning together is the only way we can bring it about. (pp. 6 & 1)

Reasoning together, conversing together, designing together, evolving together. The challenge is nothing short of the collective consideration of a radical transformation of the social systems, which embody our attitudes and dispositions. “Our goal,” as Milbrath saw it more than two decades ago, “will be to design a new society that provides a decent quality of life while coexisting in a long-run sustainable relationship with the natural environment that nourishes it” (ibid., xi). Not only is this goal entirely relevant to current design conversations around the world, it has taken on increased in urgency as the years have passed. Indeed, it must no longer be considered a side conversation, relegated to conferences and classrooms. This is The Conversation for being and becoming with our world.

When we engage in conversation with each other, if we do so authentically and inclusively, we end up also conversing internally – with ourselves, as well as externally – with the more-than-human world of which we are a part. Through multi-faceted reflection on where we stand, where those who surround us stand, and where we would like to be, we are brought inexorably to a consideration of our ethics. We may find that we and our dearest (and not so dear) acquaintances tend to be more of the take-make-waste worldview than of the syntony-quest worldview. Although, as we will see, this may be neither pleasant nor reassuring, such awareness marks the first step toward transcendence. Here, at the threshold of conscious evolution and the capacity to creatively contribute to evolutionary consonance, we need to step back, take a look at what is happening in the “big picture,” and find ourselves somewhere there. How are we contributing to that big picture? Are we over there with those who are heedlessly stamping down this earth, or over here, with the mindful walkers and insightful listeners?

Carolyn Merchant (in Hinman, 1996, p. 516), author of Environmental Ethics and Political Conflict, distinguishes among three approaches to environmental ethics:

An egocentric ethic is grounded in the self and based on the assumption that what is good for the individual is good for society. A homocentric ethic is grounded in society and based on the assumption that policies should reflect the greatest good for the greatest number of people and that, as stewards of the natural world, humans should conserve and protect nature for human benefit. An ecocentric ethic is grounded in the cosmos, or whole environment, and is based on the assignment of intrinsic value to nonhuman nature. This threefold taxonomy may be useful in identifying underlying ethical assumptions in cases where ethical dilemmas and
Vision and Values for a World of Insurmountable Opportunities

conflicts of interest develop among entrepreneurs, government agencies, and environmentalists.

There is also a fourth stage, a truly transcendent and evolutionary level of ethical consideration that should serve as the basis for the self-directed sustainable change efforts of a self-reflective global species such as ours. It is what I have been referring to in this paper as evolutionary ethics. Without a doubt, ecocentric ethics is a highly evolved expression of human consciousness given that it assigns intrinsic value to “the whole environment, including inanimate elements, rocks, and minerals along with animate plants and animals” (Merchant in Hinman, 1996, p. 524). But it is still synchronic, considering “the big picture” only at any one point in time. An evolutionary perspective needs to infuse this ethic to make it truly sustainable in the long run. Otherwise it is just optimizing what is, not working in stewardship of what should be.

Years ago, C.H. Waddington anticipated the challenge for conversations based in an evocentric ethic. He pointed out that

we have found ourselves faced by a series of problems – atomic warfare, the population explosion, the food problem, energy, natural resources, pollution and so on – each complex enough in itself, but then it turns out that each of these is only one aspect of, as it were a Total Problem, in which all aspects of the world’s workings are inter-related. (in Merry, 1995, p. 78)

This is what others, such as the Club of Rome, have termed the global problematique, and as Waddington suggests, it must be considered as a continually unfolding condition. An ecocentric ethic simply will not bear up to the challenge of dealing with it (much less a homocentric ethic, while an egocentric ethic can only make it worse). The time is nigh for societal design conversations based on an evocentric ethic.

CONCLUSION

Imagine what it would be like to flow the universe – to live in harmony with Planet Earth and to consciously and ethically explore our human potential. To be so attuned to the warp and weft of the dynamics of change that every thought, action and inaction contributed to the emergence of life affirming, future creating, opportunity increasing relationships - consciously, purposefully, and yet effortlessly, naturally. This is the promise of the next stage in the conscious evolution of our species. To attain it, and to experience such complete consonance with the flow of life in what Teilhard de Chardin would have called an experience of syntony, requires a new ethic, and a new process to cultivate its emergence.

Like all forms of truly creative and life-affirming societal evolution, the fostering of an emergent evolutionary ethic through design conversation can only be done in relationship - with oneself, with others, with nature, and with the potential inherent in the bridge we represent between what has been and what is yet to be. And it involves training - and
practice. Lots of practice, even though learning to develop your syntony sense is more like learning how to love than it is like following a manual of instructions for how to do anything in particular.

- At the first level - syntony with oneself; personal or internal syntony - the practices involve centering, quieting the monkey-mind, listening with every cell of our being. These practices cultivate intuition, compassion, insight that matches outsight, and a willingness to explore and follow our deepest calling.

- At the second level - syntony with others; community or interpersonal syntony - the practice involves deep dialogue and collaboration. Coming together to learn with and from each other and to engage in collective action with empathy, considerateness, openness, and joy.

- At the third level - syntony with nature; ecosystemic or transpersonal syntony - the practices involve communing; listening to the messages of all beings (whether they be waterfalls, animals, mountains or galaxies) and acknowledging our interdependence and ultimate unity.

- At the fourth level - syntony with the flows of being and becoming; evolutionary or integral syntony - the practices involve learning how to read the patterns of change of which we are a part; learning how to hear the rhythms of life and becoming familiar with the improvisational jam session that nature has been playing since time immemorial. These practices cultivate our ability to play our own piece; to sing and dance our own path into existence in harmony with the grand patterns of cosmic creation.

Integral responses to the complexity of contemporary global and local challenges – personal, organizational, planetary – require an expanded perspective: a way of recognizing interconnections, of perceiving wholes and parts, of acknowledging processes and structures, of blending apparent opposites. But most important, they require collaboration. Individual solutions and breakthrough ideas are necessary but not sufficient. Real opportunity to affect change arises from the systemic synergies that we create together. The Club of Rome coined the term "global problematique" to describe the complex entanglement of the collective challenges we face at any given point in time. It is our task to create "solutionatiques" – systems of shared solutions that arise from the genius of each person. To do so, we need to create an ecology of new ways of working, learning and living that embody social and environmental integrity. In short, we must learn to design systems of syntony.

Our evolutionary trajectory has prepared us for this moment in history. We have the cognitive and emotional capacity to embark on this quest for syntony. The question is whether or not we have the will, the vision, and the conviction to do so.

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NAVIGATING SOCIAL COMPLEXITY

Ken Bausch

ORIENTATION

Complexity is a term applied to systems that confound our efforts to spell out their inner relationships. Chaos theory has found laws that describe how self-organization works.

Complex social systems have special characteristics. Such social systems have been described by Ackoff as “messes” that present “wicked problems” (Rittel) because any effort to influence the system results in unanticipated consequences. Any attempt to make sense of such global problems has been termed by Ozbekhan (1970b) a “problematique.”

As with all complex systems, complex social systems resist efforts to spell out their inner workings. In fact, they confound reductionist efforts even more because social realities are constructed by people into often conflicting realities. It might see that chaos thinking is the only consistent way to deal with them.

We humans recoil against that idea. We insist on tinkering with our social systems to make them better. We are often successful especially in simpler social situations but even in some more complex ones. This success usually happens because people use their common sense and not because they follow some university inspired blueprint. There are some problems, however, that resist our rational tinkering. When we correct one aspect of these problems we mess up its other aspects. Getting a solid problematique of the situation eludes us.

The distinguishing aspects of social systems are the human beings who create them in history and the cognitive maps they retain for understanding them. These human beings are the keys to making sense of complex social systems. If we can get a meeting of minds among diverse, intelligent, and informed people, we can create a realistic problematique for wicked problems. To achieve such problematiques, we need to enable that “if.”

Achieving effective collaborative action by means of egalitarian discussion is notoriously difficult. We have all sat through meetings where only one side of a complex situation was discussed. We have also been in meetings where differing views were expressed, but the discussants did not really understand each other or really listen to opposing views. The debates that ensued generated more heat than light.

We may have experience genuine dialogues where divergent groups of people actually listened to each other. These dialogues generate mutual understanding and respect. They defuse hostile situations. They lead to solutions of many social problems.
Navigating Social Complexity

Unstructured dialogues get waylaid, however, in trying to find solutions for complex social problems. They fall victim to a range of social pathologies and to cognitive overload. In such situations groups are afflicted with groupthink, spreadthink, and the Erroneous Priorities Effect (EPE).

THREE AXIOMS OF DIALOGIC DESIGN

Over the last 35 years a select group of systems theorist/practitioners has settled upon three axioms that underlie the science of dialogic design: They are the axioms of: complexity, cognitive limitations, and saliency.

Complexity Axiom: Complex social systems designing situations are multidimensional. They require that observational variety should be respected in the dialogue among observers, in an effort to strive for comprehensiveness. Comprehensiveness, however, is an objective not easily attainable by human observers.

If comprehensiveness is neglected, important considerations may be ignored. Narrow interest can be thrust upon people unknowingly. Relationships can be warped by inappropriate metaphors. Emergent solutions will lack sufficient noise.

Cognitive Limitations Axiom: Observers are subjected to cognitive limitations during social-systems-designing dialogue, which must be explicitly recognized and avoided during the dialogue. Cognitive limitations demand that designing teams: (a) control the pace of knowledge generation and assimilation, and (b) control the number of observations and relationships that observers must manage simultaneously during the dialogue.

The primary limitation of human intelligence lies in the limits of our short-term memory. This limitation is expressed in Miller’s (1956) famous formula of “7 ± 2.” In other words, we can hold only 5 to 9 things in our short term (working) memory at the same time. Simon’s (1974) research indicates that people tend to “satisfice” when they reach the limits of their bounded rationality. Structured Dialogic design utilizes several strategies to work around this limitation:

• Precise definitions and stages of inquiry
• The mathematics of set theory to produce software that tracks the logic and requirements of the designing system. The software shortens the decision-making process, keeps track of the logic and generates products for the examination of stakeholders
• A smooth interface that integrates natural and graphic language producing efficient graphic language patterns.

Saliency Axiom: During social-science-designing dialogue, understanding the relative saliency of observations can be brought into play only when the observer’s authenticity, learning, and appreciation of variety are ensured so that the observers are able to
construct categories of observations before assessing the relative saliency of individual observations.

This axiom has particular importance in our age where we no longer have an overall meta-narrative accepted across diverse groups of people concerning norms of rational action or values (Christakis and Bausch, 2006).

**LAWS OF DIALOGIC DESIGN**

This same group of systems theorist/practitioners has refined seven laws of Dialogic Design. These laws build upon the three axioms. They form the basis of an overall science of Dialogic Design.

Ashby’s (1958) Law of Requisite Variety: This law asserts that a design must possess an amount of variety that is at least equal to the variety in the problem situation. One way to violate this law is to neglect some of the relevant perspectives and types of observers, and by not asking them to present their observations. Another way to violate the law is to disregard the cognitive limitations of the observers participating in the design.

Miller’s (1956) Law of Requisite Parsimony: This law, as already discussed, asserts that human beings can deal with only 5 to 9 observations at one time.

Boulding’s (1966) Law of Requisite Saliency: This law refers to the range of importance that people assign to observations relative to other observations. It requires that good designs (1) highlight the different ways that group members judge the saliency of design options and (2) provide specific ways to reach consensual accommodation about relative saliency.

Peirce’s (Turrisi, 1997) Law of Requisite Meaning: This law expresses in explicit terms the objective of inquiry and design – to discover the essence of problem situations and to plan desirable futures for communities of stakeholders. It states: In addressing complex design situations collaboratively, the observations of the stakeholders must be excavated though disciplined inquiry in order to grasp their full meaning. Armed with this understanding, the community can: (a) construct authentic, anticipatory, and autonomous descriptions of those observations, (b) interpret their meaning, and (c) transfer these descriptions in accordance with the tenets of Third Phase Science; that is, with full respect for the wording and autonomy of their authors.

Tsivacou’s (1997) Law of Requisite Autonomy of Distinction-Making: This law asserts that power in the design situation derives to the person who makes the distinction adopted by the group. It says: the actors that have the chance to dictate the selection of the dominant explanatory path immediately put themselves into a position of power, reducing the others involved into a position of powerlessness. Independent of the social status and role, those who control the information distinctions in a given situation acquire power and restrict the autonomy of the others.
Navigating Social Complexity

Usually, this power is wielded by the rich, the powerful, and the experts in a domain of knowledge. For good design, a corollary of this law demands that all participants must have an equal opportunity to explain their experience in the praxis of living. Only then will the power of persuasion be equitably distributed among the observers. It is not unusual that the key observation that illuminates a situation is made by some otherwise obscure person who would not have been heard if special care had not been taken to protect individual autonomy and authenticity.

Dye’s (1999, 2007) Law of Requisite Evolution of Observations: This law was recently established by comparing two stages in the Structured Dialogic Design (SDD) process – importance voting and influence voting. Importance voting uses pair comparisons asking is observation A more important than observation B. Influence voting, on the other hand, uses paired relationships and computer assistance to ask and track a series of questions of the following nature: If we were able to accomplish Observation A, Would that significantly enhance the requirement proposed by Observation B?

The conclusions of this research are:

- Importance voting and Influence voting produce radically different results.
- Dialogues must go beyond mere consensus on the “importance” of elemental observations (problems, objectives, options, etc.) if they are to effectively deal with complex social systems.
- “Influence” voting identifies the key leverage elemental observations that must be addressed in order to effectively intervene and improve a situation.
- Using “importance” voting as the basis of action results in the Erroneous Priority Effect (EPE) and undermines the effectiveness of subsequent action.

Laouris’ (2007) Law of Requisite Action asserts that action plans that are not founded on the authentic engagement of the stakeholders in dialogue and deliberation are unethical and are bound to fail.

These laws and other means of obviating the burdens of dialogue are incorporated in Structured Dialogic Design (SDD) which is described in a recent book by Christakis and Bausch www.harnessingcollectivewisdom.com.

**HOW SDDP WORKS**

SDDP is a prescriptive science. It is similar to the science of architecture in showing us how to proceed to create sound decisions and social designs. The observer-independent data, such as apples falling from trees, which are preferred for the analysis and design systems, have limited utility in complex social system situations. For that reason SDD uses observer-dependent data.

SDDP fits into the category of “Third phase science” as defined by Gerard de Zeeuw (1996). The three phases are defined as follows:
"First phase science" refers to that form of science in which it is assumed that the construction of high quality observations can be *fully separated* from the actions that are to be improved by their use (e.g., astronomy).

"Second phase science" refers to that form of science in which it is assumed that the construction of high quality observations *fully depends* on the actions that are to be improved by their use (e.g., first order cybernetics).

"Third phase science" refers to that form of science in which it is assumed that the construction of high quality observations *fully includes* the actions that are to be improved by their use (e.g., second order cybernetics). (de Zeeuw, 1996).

Third Phase Science grounds its legitimacy in engaging stakeholders as “expert observers” of the situation in which they are embedded. They are the ones that should decide how to take action in their situation, since they are those most affected by the existing situation and its evolution. This grounding stands in contrast to first and second phase sciences, which assert that “academic experts” or authorities are more qualified to design the “systems” on behalf of the community of stakeholders (Christakis and Bausch, 2006).

The step-by-step process of SDDP is described below.

Step (a) is not really a step. It is the complex situation that Structured Dialogue is asked to address. It consists of many interrelated institutions, ideas, cultures, economic constraints, etc. This hodgepodge is investigated with the goal of framing apt triggering questions.

In step (b), the triggering questions frame the context of the dialogue. A sample triggering question might be: "What are the strengths of this organization and what is hindering its progress?"

In response to this question, the participants articulate their ideas in their own words to the full attention of the other participants, step (c). Their words are posted on a wall and everyone agrees not to alter them. In a second round robin, step (d), participants respond to questions asking them to clarify (not to alter) their ideas, and are given the opportunity to respond to questions in order to explain their meaning.

This methodology authenticates each person irrespective of his or her education level or position of power. It produces a palpable reduction of tension. People seem surprised as they are being heard, perhaps for the first time, in important policy-making matters.

In step (e), the participants collaborate to inductively cluster the observations they have made. Then in step (f), they agree upon labels for the clusters they have created. These steps build a sense of shared competence within the group.

In step (g), participants rank these clusters according to their relative importance. This step brings into sharp relief the different priorities and values within the group. In the ensuing discussion, parties come to understand where their co-participants are coming from, which leads to a respectful working relationship based on defined mutual interest.
Navigating Social Complexity

In step (h), participants explore relationships among the observations and construct a tree of relational influences. In this step, they order their observations in paired comparisons asking whether A really influences B, and vice-versa.

Finally in steps (i) and (j), the stakeholder/designers examine the "tree of meaning" they have constructed, with computer assistance. As a group, they analyze and interpret the cross-impacts existing among the observations they have made.

In these ways, step-by-step, Structured Dialogue progressively clarifies the situation and opens the way to greatly enhanced decision-making and action-planning. In addition it:

• Authenticates every stakeholder/participant;
• Elicits ideas and points of view from all stakeholders;
• Moves toward effective consensus;
• Elicits and deals with the different priorities of stakeholder participants;
• Equalizes power relations among the stakeholders;
• Goes beyond identifying factors that are important, to specifying those that are most influential in achieving goals.

Subsequent steps of SDDP build upon this strong foundation.

CONCLUSION

It would seem that the sciences of Chaos/Complexity and Structured Dialogic Design both have important things to say about social complexity, but from different points of view. Chaos/Complexity relies as far as possible on observer-independent data and describes how complex systems change. In this way they supply clues that enable us to influence systems at their tipping points.

SDDP relies upon observer-dependent data in order to prescribe the most desirable and efficient ways to change existing situations.

REFERENCES

Navigating Social Complexity


HOLISTIC METHOD FOR ELABORATING RISK MAPS IN RURAL ZONES

F. Aceves, J. Audefroy, I. Peón

Risk maps are needed
for locating exactly the most dangerous places,
but also for locating the safest places,
where help centers can be located.

INTRODUCTION

Many areas of the world are located at high risk of disasters zones. As a matter of fact, more than half of the populated zones of the world are under risk, either by earthquakes, volcanic eruptions, hurricanes, earth slides, flooding, tsunamis, fires, epidemics, etc. But this is not the main problem; after all, life is always at risk. The main problem is that, frequently, the persons are not aware of the risk, and they are not prepared for facing emergencies, for preventing and/or mitigating the effects of disasters originated by extra-ordinary phenomena, natural or anthropogenic.

To face the recurrent and growing disasters, the civil authorities have created different official instances for the civil protection of the citizens, but these instances need high risk maps, in order to locate the places where disasters have happened before, or could happen in the future, with the purpose of preventing or mitigating them in a better way.

In many great cities of the world, some very sophisticated, modern and high cost methods have been used to elaborate risk maps, which include satellite images, historic written chronologies, and interviews with some people of those cities. But this methodology is too costly and sophisticated for being applied in rural zones, where bibliographic resources are scarce.

For rural zones, where disasters have happened recently, with excessive frequency, like in Chiapas, Mexico, it is needed to develop a methodology ad hoc for elaborating risk maps at a minimum cost. To do so, in 2007, a research project named “Generation of geo-referenced information from the Chiapas mountains region” was executed, with the financial support from SEDESOL (Social Development Secretary)

METHODOLOGY

With the purpose of developing a methodology ad hoc for elaborating risk maps, feasible with local resources and at a minimum cost, several trips were made in order to know the local problematic and the available local resources potential. It was detected that there were not written bibliography, but oral memories from the more ancient inhabitants. The alphabetization level is very low, which means that very few people knows how to read, write and design maps. But it was found that with the help of moral
Holistic Method for Elaborating Risk Maps in Rural Zones

leaders, such as the priest of the local church, it is feasible to work with the most capable local persons in order to get acceptable, trustful and sure results. With these elements we worked to develop the methodology showed in this paper.

The most relevant aspects of this methodology for elaborating risk maps in the rural zones are explained as follows:

1- Since there is not much historic written information about what has happened in the zone, then we need to take advantage of the oral information from the ancient inhabitants of the zone, by means of structured or informal interviews, in order to know what kind and magnitude of disasters have happened, and actions that they think could be useful for preventing and mitigating them in the future. This information is very useful, because it reflects the experience of the persons more interested in getting a risk map well done, with the best recommendations for minimizing the effects of the extra-ordinary phenomena that are the origin of future disasters.

2- Since usually there are not maps of the physical location of dwellings or public services in the rural zones, or the places that have been affected in the past by the extra-ordinary phenomena (such as earth slides, flooding, etc.) it is necessary to elaborate maps, by hand, as the first step, of this communities, showing the most dangerous places that have been affected in the past, and showing, also, the safest places, where a help center, such as a clinic or a food storage, could be installed. This risk maps must be elaborated with symbols easily understood for the members of the community, in such a way that everybody understand the information written in those maps.

3- The exact location of a rural community may be found by means of a GPS (General Positioning System) which works by means of satellite signals, and may give the exact coordinates of the place, altitude, latitude and longitude. This GPS is not expensive (about 300 USD) and can be utilized by any person previously trained.

4- Since it is very expensive to hire specialists who must come from outside, it is more convenient to train local people, which have some advantages and some handicaps. The advantages are that local people know better the zone, the local problematic, and the more ancient persons that may give the historic information by means of interviews. Besides, they are the people more interested in making a good risk plan, since it is vital for them and their families. Some limitations are that their level of alphabetization and their capabilities for making plans are limited, so they should be trained and supervised.

5- In order to solve these limitations it is necessary to have the support of some moral authorities in the community, such as the teacher, the priest, and/or the political authorities, who can aid to find the most suitable persons that may be trained to make the interviews and the risk maps.
Holistic Method for Elaborating Risk Maps in Rural Zones

6- The training of local persons should be made by specialist, who at the beginning, could come from outside. This trainers should start their courses remarking the importance of the work that has to be done, then they should continue to give information about how to use the GPS, and finally, they should train the trainees for making interviews and for elaborating the risk maps.

7- Finally, all the information generated by the local trainees, should be supervised and edited by the specialist, in order that the risk maps arrive to be trustful, clear and usable for the local authorities and the members of the community.

The holistic method for developing risk maps in rural zones consist of seven steps, as follows.

1- The expert, responsible of the task or developing the risk maps, meets the moral and official leaders of the community in order to get their help for doing the pre-diagnostic of the risk problematic in the zone, and for detecting the local partners who may work in the zone.

2- The expert trains the local partners for interviewing the more ancient inhabitants in the region, for drawing maps locating dwellings an important sites in the region, and for manipulating the GPS (Global Positioning System)

3- Local trained partners interview the more ancient inhabitants of the community, in order to get information about the risk of disasters in the region.

4- Local trained partners draw the map of the community showing the dwellings, public services and the most sure and unsure places, exactly located by means of the GPS

5- Supervisar el trabajo de campo y editar el mapa de riesgo.

6- The expert supervises the interviews and maps made by the local partners and edits the risk map.

7- The expert shows the edited risk map to the main partners in the community in order to check that everything is correct, and for correcting in the case it is not.

8- The expert delivers the finally corrected and approved risk map to the local protection civil authorities, to the leaders of the community, and to the partners that participate in the collection of data and drawing of the risk map, in order that they use it in their plans and programs for disasters prevention and mitigation.

This methodology has been developed for the physical and cultural characteristics of the mountain zone of Chiapas, Mexico in 2007, and should be re-adapted and re-appropriated to other regions in case that it is needed for other regions and cultural characteristics.
Holistic Method for Elaborating Risk Maps in Rural Zones

In the annexes it is showed the format to execute the interviews, and an example of a risk map developed with this methodology in a small community of Chiapas Mexico.

It is convenient to re-make this risk plans each three years or so, since the governmental period of the municipal presidents is exactly this amount of years. The circumstances and the persons change constantly, so the risk maps should actualize constantly, and especially, they should serve as the basis to prepare the contingency plans in order to prevent and mitigate future disasters.

CONCLUSION

In order to get risk maps in rural zones truthful, and at a low cost, it was developed in 2007 a holistic-participative method that allows us to get them in rural zones of Chiapas, Mexico.

By means of this holistic-participative method, it can be obtained several advantages:

1- The risk maps developed with this method are more trustworthy since the information is obtained by local partners who know and understand very well the local problematic and they are very interested in making a good work, since their own life is in peril.

2- The exact location of the most dangerous and surer places in the region is obtained by means of a GPS (General Positioning system), the most exact available technology for locating a place in the earth surface.

3- The risk maps developed with this method are easily understood by the members of the community and by the civil protection authorities, since they are processed by specialist with the help of local partners.

4- Training local partners is very useful because they are always available for the community, and they will help local authorities to prepare and to implement community contingency plans to prevent and mitigate the impact of extra-ordinary phenomena that are at the origin of disasters.

5- The cost of developing these risk maps is relatively lower than with other urban areas methods since it is not necessary to pay many specialists with room and board and transport, but only to pay local partners at a reduced rate.

With this holistic method, the best of possible worlds is obtained in disasters prevention and mitigation matters. The experience of local partners is taken into account and the knowledge of the specialists is profited to develop the risk maps, at a minimum cost.
REFERENCES


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Annex A  Format used for interviewing the oldest citizens in the community.

LEVANTAMIENTO ESTADÍSTICO – RIEGOS CHIAPAS

Realizado por _________________________________ Fecha (Día/mes/año)

1. Nombre de persona entrevistada____________________________________________________________

2. Ocupación: maestr@ ( ), párroco o pastor ( ), representante político ( ), jefe o jefa de hogar ( ), otro ( ): _____

3. Forma de localizarlo: teléfono ________________, otro ________________________________

SECCION UNO: DATOS GENERALES

1.1 Comunidad: _______________________________ 1.2 Municipio: __________________

1.3 Número total de viviendas en la comunidad 

1.4 Número de habitantes en la comunidad, TOTAL: _______, Hombres: _____ Mujeres: _____

SECCION DOS: ASPECTOS FISICOS NATURALES

2.1 Tipo de terreno: Plano ( ), Serranía ( ), Mixto ( ), Otro: ____________________________

2.2 Clima: Cálido Húmedo ( ), Cálido Seco ( ), Templado ( ), Otro: ____________________________

2.3 ¿La comunidad está muy cerca o en el cauce de un río?  Si ( ), No ( )

2.4 ¿Existe el riesgo de un deslave cerca o en la comunidad?  Si ( ), No ( )

2.5 ¿Existe el riesgo de temblor en la comunidad?  Si ( ), No ( )

SECCION TRES: ASPECTOS URBANOS

3.1 ¿Tienen red de electricidad?  Si ( ), No ( )

3.2 ¿Tienen red de agua entubada?  Si ( ) No ( )

3.3 ¿Tienen red de recolección de drenaje?  Si ( ), No ( )

3.4 ¿Tienen servicio de recolección de basura?  Si ( ), No ( )

3.5 ¿Tienen servicio de transporte público?  Si ( ), No ( )

3.6 ¿Cuentan con comunicaciones? Radio-transmisor ( ), teléfono ( ), Otro ( ): ____________________________
3.7 ¿Cuentan con centro de salud? Sí ( ), No ( )

3.8 ¿Cuentan con escuela de nivel? Kínder ( ), Primaria ( ), Secundaria ( ), Otro: ______________________

3.9 ¿Cuentan con un edificio o casa comunal grande? Sí ( ), No ( )

3.10 ¿Qué Iglesias o templos existen en su comunidad? Católica ( ), Protestante ( ), Otro: ______________________

SECCION CUATRO: CARACTERÍSTICAS DE LA CASA TIPICA

La casa más común, típica o normal en la comunidad, se construye con los siguientes elementos:

4.1 Paredes: Palos-Bahareque ( ), Tablas de madera ( ), Adobe ( ), Ladrillos-bloques ( ), Otro: ______________________

4.2 Techos: Lámina de Cartón ( ), Lámina galvanizada ( ), Rama de palmera ( ), Loza de concreto ( ), Otro: ______

4.3 Piso: Tierra ( ), Firme de concreto ( ), Loseta/Mosaico ( ), Otro: ______________________

4.4 Numero de cuartos en la casa: 1 cuarto ( ), 2 cuartos ( ), 3 o más cuartos ( )

4.6 Instalaciones con las que cuenta la casa: Agua entubada ( ), Drenaje ( ), Electricidad ( ), Teléfono ( ), Otro: ______________________

4.7 Para cocinar usan: Fogón al piso ( ), Fogón elevado con chimenea ( ), Estufa de gas o eléctrica ( ), Otro: ______

SECCION CINCO: ASPECTOS SOCIALES-CULTURALES-ECONOMICOS

5.1 Lengua(s) que hablan: Español ( ), Otra(s): ______________________

5.2 Nivel de escolaridad promedio en la comunidad: Sin estudios ( ), Primaria ( ), Secundaria ( ), Otro: ______

5.3 Actividades normales de un hombre adulto Agricultura ( ), Ganadería ( ), Albañil ( ), Comerciante ( ), Otro:

5.4 Actividades normales de mujer adulta Hogar ( ), Agricultura ( ), Ganadería ( ), Artesanía ( ), Comerciante ( ), Otra: ________________

5.5 Actividades normales de jóvenes: Estudiar ( ), Ayudar en casa ( ), Trabajo fuera de casa ( ), Otra: ______

5.6 Gasto anual de la familia típica: menos de $10,000 ( ), de 10,000 a 20,000 ( ), de 20,000 a 40,000 ( ), más ( )
SECCION SEIS: RIESGOS DE DESASTRES

RIESGOS DE DESASTRES DETECTADOS EN LA COMUNIDAD

6.1 Huracanes-Tormentas tropicales: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.2 Inundaciones: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.3 Deslizamientos o derrumbes de terrenos: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.4 Sismos/terremotos: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.5 Erupciones volcánicas: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.6 Sequías: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.7 Incendios: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.8 Granizadas/heladas: 10 años atrás ( ), 5 años atrás ( ), 2 años atrás ( ), éste año ( )

6.9 Otros

6.10 ¿Cuáles de estos problemas afectan más tu comunidad? _____________________________
¿QUÉ SE PUEDE HACER PARA REDUCIR EL RIESGO Y PREVENIR LOS DESASTRES? PALOMEE LAS OPCIONES RECOMENDABLES

7.1 Ubicar viviendas lejos de ríos o de zonas de derrumbes ( )
7.2 Mejorar el tipo de construcción de viviendas para soportar huracanes y sismos ( )
7.3 Realizar obras para evitar el deslizamiento de terrenos ( )
7.4 Realizar obras para evitar o controlar inundaciones ( )
7.5 Contar con centro comunitario, en lugar seguro, donde albergar a la comunidad, en caso necesario ( )
7.6 Contar con sistemas de agua potable y de letrinas de emergencia ( )
7.7 Contar con reservas de alimentos y agua para sobrevivir por lo menos una semana ( )
7.8 Contar con servicios de emergencia y de salud locales ( )
7.9 Capacitar a miembros de la colonia para el manejo correcto de los riesgos de desastres ( )
7.10 Capacitar a los miembros de la comunidad para mejorar sus ingresos económicos ( )
7.11 Educar a los miembros de la comunidad para que cuiden la naturaleza y la vida humana( )
7.12 Otros:
SECCIÓN OCHO: NECESIDADES SENTIDAS POR LA POBLACION

¿Qué crees que tu comunidad necesita con más urgencia? (pueden ser varias necesidades en cada categoría)

8.1 Más urgente:

______________________________

8.2 Medianamente urgente:

______________________________

8.3 Menos urgente:

______________________________

SECCION NUEVE: RADIOCOMUNICACIÓN

9.1 ¿Quién es la persona responsable del equipo de radio-comunicación?

______________________________

9.2 Fecha aproximada en que se instaló el equipo de radio-comunicación

______________________________

9.3 ¿De qué comunidades reciben normalmente señal de radio-comunicación?

______________________________

9.4 ¿Cuántas veces al día usan normalmente la radio-comunicación?

______________________________

9.5 ¿Cuántas veces durante los últimos tres meses se uso el radio para dar aviso de:

- Emergencias médicas: _______, Accidentes: _______,
- Derrumbes: _______, Inundaciones: _______,
- Invitación a reuniones: _______, Venta de productos: _______,
- Otro (indicar): _______

______________________________

¡GRACIAS POR EL APOYO BRINDADO!
SECCIÓN DIEZ: UBICACIÓN GPS (General Positioning System)

10.1 Entrada principal a la comunidad: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.2 Escuela preescolar: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.3 Escuela primaria: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.4 Escuela secundaria: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.5 Escuela de capacitación: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.6 Iglesia Católica: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.7 Iglesia (otra): Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.8 Cancha deportiva: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.9 Centro de salud: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.10 Centro comunitario: Latitud: N_______ Longitud: W_______
Altitud: ___________ m

10.11 Lugar seguro y sin cables aéreos para aterrizaje de helicópteros (mínimo: 30X30 metros)
Latitud: N_______ Longitud: W_______
Altitud: ___________ m

SECCIÓN ONCE: MAPA DE RIESGOS EN LA COMUNIDAD

CROQUIS DE LOCALIZACION GEOGRÁFICA y MAPA DE RIESGOS EN LA COMUNIDAD

(Relacionándolo con comunidades y ciudades vecinas y caminos y carreteras)

Nota: Dibujarlo en el reverso de la página.
Annex B. Examples of risk maps developed with the Holistic Method
Holistic Method for Elaborating Risk Maps in Rural Zones

Chimalapa

Estado: Chiapas
Región: Sierra
Municipio: El Porvenir de Villasco

MAPA DE RIESGO

Comunidad Chimalapa

Municipio: El Porvenir, Chis.

BARRIO: JORGE DE LA VEGA

ZONA DE DERRUMBE

RESERVA DE RAMOS AIRENAS

Zona de vegetación densa

CASA
IGLESIA
ESCUELA PRIMARIA
TELESECUNDARIA
ZONA DE ATERIZAJE

CASADA
CAMINO
RÍO
CAUCE
PUENTE

Cerro de Male
N 15° 27'04" W 92° 14'51" A 2840 m

N 15° 23'58" W 92° 14'28" A 1160 m

RIESGO DE INUNDACIÓN

Zona de riesgo

CASAS
LATA DE AGUA
Zonas Abiertas
CAMPO
CAMINO
CENIZA
EPA
PAN
Zonas de derrumbes
Zonas de declive
Zonas de vegetación densa

Riesgo medio
Riesgo bajo
Riesgo alto

Mapa elaborado con base en datos geográficos y reportes técnicos.

Diseño 2017

Data de la base de datos: 04/09/2017

13
Holistic Method for Elaborating Risk Maps in Rural Zones
ONTOGRAPHY-DRIVEN DECISION SUPPORT SYSTEMS FOR MANAGEMENT SYSTEM AUDIT

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ABSTRACT

Many types of management system audit are widely spread in the companies, e.g., quality management system audit, etc. The management system audit can be regarded as management decision-making. But there are very few decision support systems for management system audit, since management system audits are different from usual management decision-making. For management system audit, management standard is developed, and auditors must verify that an individual management system of a company consistent to the requirements of management system standards. Ontology is information structure, which helps to acquire knowledge, share it, and check consistency within the knowledge. One of our main aims of this paper is to present a methodology of ontology-driven decision support systems for management system audit. Firstly, we characterize the management system audit as a new decision-making. Next, we introduce a concept of ontology formally, and develop generic management system ontology, and company quality management system ontology. Finally we present a methodology of ontology-driven decision support system for management system audit, and show the characteristics of the decision support system.

Keywords: Management system standard, decision support system, ontology, audit

INTRODUCTION

Decision-making is one of the main research themes of systems science, and decision support systems (DSS) were developed in many area; e.g., management decision-making, group decision-making, etc. DSS helps the decision-maker to gather information, generate alternatives, estimate the values of alternatives, and to make choice. Power (2007) classified DSS as model-driven DSS, data-driven DSS, communications-driven DSS, document-driven DSS, knowledge-driven DSS, web-based DSS. In the most of DSS, decision-making may be regarded as a choice between alternatives based on the estimation of the values of the alternatives. Now many types of management system audit are widely spread in the companies, e.g., quality assurance management system audit, environmental management system audit, information security management system audit, etc. These management system audits can be regarded as management decision-making. But there are very few DSS for the management system audit, since management system audits are different from usual management decision-making. For management system audit, management standard is developed, and auditor must verify that an individual management system of a company consistent to the requirements of management system.
Ontology-Driven Decision Support Systems for Management System Audit

standards. In usual decision-making, to generate alternatives, to estimate the values of
alternatives, and to make choice are important. And DSS want to support these activities.
But in management system audit, to gather management information, translate the
information to the generic management system standard, and to check the consistency of
the management system to the generic management system standard. Gehrmann et al
(2005, 2008) introduced the concept of ontology in order to support management system
audit. Where ontology is information structure, which helps to acquire knowledge, share
it, and check consistency within knowledge. One of our main aims of this paper is to
present a methodology of ontology-driven decision support systems for management
system audit, and to clarify the characteristics of the ontology-driven decision support
system. Firstly, we characterize the management system audit as a new decision-making.
Next, we introduce a concept of ontology formally, and develop generic management
system ontology, and company quality management system ontology. Finally we present
a methodology of ontology-driven decision support system for management system
audit, and show the characteristics of the decision support system

CHARACTERISTICS OF MANAGEMENT SYSTEM AUDIT

In this paper, we focus on the quality management system audit as a typical sample of
management system audit. ISO 9000 family is a set of standards for the quality
management system audit, and consists of IOS 9000, 9001, and 19011. ISO 9001 is a
main standard in ISO 9000 family, and is a standard for the requirement of the quality
management system. ISO 9000 is a standard for the terminology for quality management
system, and is used for the definitions of the requirements of quality management system.
ISO 19011 is guidance for the audit. The main focus of the management system audit is to
determine if the management system has been developed, is effectively implemented, and
is being maintained. Management system audit should be on verifying conformity. An
organization becomes registered/certified on the basis that it has effectively implemented a
management system that conforms to the requirements of ISO 9001. The characteristics
and difficulties of management system audit may be summarized as follows.

Characteristics of management system audit

1. Management system audit is performed by the form of document audit and on-site
audit. Auditor acquires the company knowledge which related to the management
system standards.
2. Auditor acquires many types of partial knowledge from the audit activities of on-site
audit, and auditor need to synthesis the knowledge according to the management
system standards.
3. Auditor has generic management system standard, and auditor must verify that an
individual management system of a company conform the requirements of
management system standard.
4. Auditor need to communicate with auditee in order for auditee to accept the result of the audit decision easily.

Difficulties of management system audit
1. Audit knowledge is acquired by document audit and on-site audit, and the form of the audit knowledge is very flexible. Knowledge acquisition of audit is not easy.
2. Audit knowledge has to be translated to the terms of generic management system standards in order to understand the situation of the company’s management system. It is not easy to translate the audit knowledge about management system into generic management system standards.
3. Audit knowledge is partial knowledge about management system. We need to synthesize the partial audit knowledge according to the management system standards. But it is difficult to address the partial knowledge and synthesize them.
4. Auditor must judge whether the management system is conform to generic management system standards or not. This decision is not easy, and this decision is usually dependent on the personal ability of the auditor.
5. The collaboration with auditors and auditees in not easy. We need some communication tool among auditors and auditees.

CONCEPTS OF ONTOLOGY AND MANAGEMENT SYSTEMS ONTOLOGY

Concept of ontology
In this section we introduce a formal concept of ontology and propose management system ontology. Ontology is an information structure, which helps to acquire knowledge, share it, and check consistency within knowledge. Gruber (2007) proposed a formal definition of ontology as a 5-tuple \( (N, R, D, F, T) \) where each element is defined as follows:
- \( N \), a set of nodes.
- \( R \subseteq N \), a set of relationTypes.
- \( D \), a set of description logic sentences. Each sentence can use the elements in \( N \) and 2 variables subject and object. Indicating respectively the first en third element in 5-tuple in \( T \).
- \( F \), a function that maps each element in \( R \) maps onto one element in \( D \).
- \( T \), is a set of relations which is defined as a set of 3-tuples where for each element consists of \( (s, r, o) \) where:
  - \( s \) is the subject, an element of \( N \)
  - \( r \) is the relation, an element of \( R \)
  - \( o \) is the object, an element of \( N \)

In ontology \( (N, R, D, F, T) \), knowledge is mainly represented by \( D \) and \( T \). \( D \) is a set logical descriptions of knowledge and may be regarded as deductive knowledge. \( T \) is a set of relationships among nodes, and may be regarded as inductive knowledge. An invalid relation is an element \( t=(s, r, o) \) in \( T \), where the description logic sentence \( d=F(r) \) in which
the variables are substituted with $s$ and $o$ returns false. The invalid relation means the inconsistency among deductive knowledge and inductive knowledge. This is a mechanism for the consistency check within the ontology. Next we introduce the ontology of management system standard.

**Ontology of generic quality management system**

ISO 9000 family is a set of standards for the quality management system audit, and consists of a standard for the requirement of the quality management system, a standard for the terminology for quality management system, and a guidance for the audit. Ontology derived by ISO 9000 family is defined by the next form.

ISO 9000 Ontology: $O_0=(N_0, R_0, D_0, F_0, T_0)$
- $N_0$, a set of nodes. $N_0$ consists of the terms and requirement of quality management standard, procedure of audit, and the following relationTypes.
- $R_0 \subseteq N_0$, $s$ a set of relationTypes. is-a relation is a typical relation type in ontology. Is-a relation shows the class hierarchy of the terminology of quality management system standard. Verbs in the sentence of system requirement may also be regarded as relationTypes.
- $D_0$, a set of description logic sentences. Some of the definitions of the terms and the conditions of the requirements are defined by description logic.
- $F_0$, a function that maps each element in $R$ maps onto one element in $D_0$.
- $T_0$, is a set of 3-tuples. ($s, r, o$) shows that node $s$ related by the relationType $r$ to node $o$. $T_0$ is a set of inductive and factual knowledge within the standard.

**Ontology of company and ontology of company quality management system**

Company may have its own ontology. It may be unclear and ambiguous for the auditor. We assume company ontology as follows: $O_C=(N_C, R_C, D_C, F_C, T_C)$
- $N_C$, a set of nodes. $N_C$ consists of the terms and rules in the company.
- $R_C \subseteq N_C$, $s$ a set of relationTypes. Names of the rules in the company may be regarded as the relationTypes.
- $D_C$, a set of description logic sentences. $D_C$ is a set of deductive knowledge and the rules in the company may be defined as $D_C$.
- $F_C$, a function that maps each element in $R$ maps onto one element in $D_C$.
- $T_C$, is a set of 3-tuples. $T_C$ is a set of inductive and factual knowledge within the company.

Through the audit activities, auditor acquires the factual knowledge of the company which is related to quality management system standard. The audit knowledge is a company knowledge which is acquired by audit activities: $(N_A, T_A)$
- $N_A, N_A \subseteq N_C$, a set of company terms or rules which are acquired by audit activities.
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– $T_A$, $T_A \subset T_C$, a set of factual knowledge of the company which is acquired by audit activities.

Ontology of the company quality management system consists of the ontology of generic quality management system and the acquired knowledge by audit activities. Ontology of the company quality management system is defined as follows: $O_Q = (N_Q, R_Q, D_Q, F_Q, T_Q)$.

- $N_Q$, $N_Q = N_C \cup N_0$.
- $R_Q = R_0$, $D_Q = D_0$, $F_Q = F_0$.
- $T_Q$, $T_Q = T_C \cup T_0$.

Figure 1 shows the relationships among generic management system ontology, company quality management system ontology, and the company ontology. Figure 1 also shows the following methodology of ontology-driven decision support system.

**METHODOLOGY OF ONTOLOGY-DRIVEN DECISION SUPPORT SYSTEM FOR MANAGEMENT SYSTEM AUDIT**

Based on the definitions of management system ontology, we present a methodology of ontology-driven decision support system for management system audit. According to the methodology, we show the interface of the ontology editor Protege.

**Methodology of ontology-driven decision support system**

0. Development of generic quality management system ontology $O_0=(N_0, R_0, D_0, F_0, T_0)$

Within the ontology $O_0$, terms of quality management system $N_0$ is represented by the hierarchical manner as shown in Figure 2 based on is-a relationType. This hierarchy of the terms is usually called taxonomy. It helps us to understand the structure of the terms.
Ontology-Driven Decision Support Systems for Management System Audit

1. Knowledge acquisition by audit activities \((N_A, T_A)\)

Figure 2. Taxonomy of Generic Quality Management System Ontology

Figure 3. Knowledge Acquisition by Audit Activities
Figure 4. Definition and Real Company’s Activities of the Requirement

Through the audit activities, auditor acquires the factual knowledge of the company \((N_A, T_A)\) which is acquired by the audit activities. For any \(o \in N_A\), \(\{s \mid (o, r, s) \in T_A\}\) will be change with flexible manner. \(\{s \mid (o, r, s) \in T_A\}\) can be regarded as the flexible check list for audit activities. Protege provides the forms as shown in Figure 3. The forms works as flexible check list and helps us to reduce the effort of input of the acquired knowledge.

2. Translation of acquired knowledge to generic quality management system ontology
Node \(o\) in acquired knowledge \(N_A\) is translated to \(s\), if \((o, \text{is-a}, s)\) in \(T_Q\). If \(o\) is translated to \(s\), then the definition of \(s\) is also applicable to \(o\). Figure 4 shows the definition and real company’s activities of the “Purchasing process” requirement.

3. Synthesis of the acquired knowledge \((N_A, T_A)\) in the context of generic management system standard ontology \(O_0=(N_0, R_0, D_0, F_0, T_0)\)
As a synthesized ontology, we can get company quality management system ontology \(O_Q=(N_Q, R_Q, D_Q, F_Q, T_Q)\) as defined in the previous section. Figure 5 shows the Synthesis of the acquired knowledge in generic quality management system ontology.

4. Consistency check of the acquired knowledge
If for any \(t=(s, r, o)\) in \(T\), the description logic sentence \(F_Q(r)\) in which the variables are substituted with \(s\) and \(o\) returns true, then the knowledge acquired by audit \((N_A, T_A)\) is consistent with generic quality management system standard. In short, if for any
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\((o,r,s)\) in \(T_d\) is not invalid relation, then the knowledge acquired by audit \((N_d, T_d)\) is consistent

![Figure 5. Synthesis of the Acquired Knowledge in Generic Quality Management System Ontology](image)

5. Making audit report.

As a result of audit activities, auditor must make audit report. Audit report generator supports auditor to select relevant factual knowledge and organize items according to the format of audit report, and publish the report. Figure 6 shows the audit report generated by ontology-driven decision support system.

![Figure 6. Generation of Audit Report](image)
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CONCLUSION
As a new type of decision-making, we introduce a decision-making for management system audit. We characterize decision-making for management system audit, and show the difficulties within the management system audit. In order to support management system audit decision-making, we introduce the ontology-driven decision support system. We define generic quality management system ontology, acquired knowledge by the audit activities, and company quality management system ontology. Based on the definition, we present a methodology of ontology-driven decision support system for management system audit. If we have conceptual models or standards, and our decision-making is close related to the consistency check among conceptual models and real systems, then ontology-driven decision support system will be useful for us.

REFERENCES
GROWTH STRATEGY AND HIERARCHY THEORY: EMERGENCE OF SUPER-PLAYERS IN THE HEALTHCARE COMPUTED TOMOGRAPHY OLIGOPOLY

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ABSTRACT

This paper examines how firms discover effective strategic positions in a business technology-driven oligopoly context (limited players, no possible entrant and rapid technological change). In such settings, neither rational deduction nor local search is likely to lead a firm to a successful growth: firms escalate by launching new products faster, developing new services or acquiring new capabilities. Demonstrating the complexity of the business oligopoly, however, allows us to define the emergence of a new type of players, “super-player”, able to write a new set of rules and to substantially influence the industry for a given period of time. With respect to the Hierarchy Theory, we find the attributes of context changing, filtering information and simplifying multilevel business systems for this “super-player”. More surprisingly, we find a succession of “super-players” that we identify as a consequence of co-evolution for a given oligopoly-type industry, in the Healthcare Computed Tomography: the “super-player” evolves in a way that the entire industry ultimately adapts itself and co-evolves in the same way.

Key Words: complex systems, growth, strategy, hierarchy theory.

1. Introduction

This paper aims to examine how firms discover effective strategic positions in a business technology-driven oligopoly context (limited players, no possible entrant and rapid technological change) by considering business oligopolies as complex coevolving systems. We firstly develop a system theoretical framework to grasp such context by adopting hierarchy theory and then apply the framework to a real business oligopoly case to validate the framework as well as to obtain unique insights about the case.

Strategy formulation and implementation is most critical in times of rapid change and in unfamiliar environment, while firms are requested to deliver the growth rates, expected by their boards and demanded by the investors. Strategy makers must identify a viable new strategic position and innovation in a large sense is usually the key driver of market change following Schumpeter (1934). Firms have to constantly adapt to a changing environment (Prahalad and Hamel, 1990; Teece, Pisano and Shuen, 1997). To create new assets, the resource-based view (Rumelt, 1984; Wernefelt, 1984; Nelson and Winter, 1982) draws on evolutionary economics (e.g., Montgomery, 1995; Barney, 2001), where new resources and capabilities emerge, develop and demise. Executives seem to recognize new challenges in today’s globally competitive environments and understand how technological innovation is necessary but not sufficient for success (Teece, 2007). Sam Pisano, CEO of IBM, remarks that
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‘innovation is about much more than new products. It is about reinventing business processes and building entirely new markets that meet untapped customer demand’. Specifically looking at the business oligopolies, firms as big players tend to multiply efforts to differentiate themselves versus competition, that we would call hyper-competition (D’Aveni 1994): firms escalate by launching new products faster and developing new services, very similar to the competitors’ offerings, where competitive advantages (Porter, 1980) do not last. From this perspective, one firm outperforms another if it is adept at rapidly and repeatedly disrupting the current situation to create a new basis for competing. With big players like multinational firms, the concept of escalation ladders from military strategist Carl Von Clausewitz accurately describes hyper-competition in this business oligopoly situation, where rapid technological change, deregulation and globalization have intensified competition and increased turbulence that strategic makers face. The rise of global organizations and the standardized information technology have created unprecedented complexity or interdependence within organizations. Recognizing the profound effects of complexity for these competing firms, we argue that such business technology-driven oligopolies work as complex systems. By complexity we refer to mathematical theories of complex adaptive systems in the physical and biological sciences (e.g. Prigogine, 1980; Kauffman, 1993; Gould 2002) and also in social sciences (e.g. Axelrod and Cohen, 2000). Management scholars have also attempted to introduce these theoretical ideas to administrative science (e.g. Burgelman, 1983; Thietart and Forgues, 1995; Brown and Eisenhardt, 1997). Moreover, looking at open systems (system that interacts with ist environment to maintain itself in existence), the trans-discipline named ‘General System Theory’ (von Bertalanffy, 1968) argued that the sorts of behavior seen in open systems in biology could be seen demonstrated by open systems in other domains. Management scholars (Stacey, 1996, 2000; Rosenhead, 1998; Jackson, 2000) did develop some seminal frameworks to deal with this business complexity as open systems

2. Business Oligopolies as Complex Evolving Systems

The previous discussion argues that at the industry level of analysis, business oligopolies may be considered as complex coevolving systems because they can change the rules of their development as they evolve over time. Simon’s (1962) essay on the architecture of complexity analyses the properties of complex systems: ‘one made up of a large number of parts that interact in a non simple way…in such systems…given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole’ (p. 468). In complex systems, the parts can be understood in terms of their relationships with each other and with the whole. The number and variety, as well as their numerous interactions make the business oligopoly being a complex system: the rules of the system are nonlinear, order is an emergent property of disorder; they do not simply adapt to their environment but co-evolve with them. A hierarchical theory is needed because the business oligopoly as a complex system is itself hierarchically arranged. As Simon (1962) pointed out, hierarchical ordering is one of the most natural ways of organizing complexity. These hierarchies are inclusive and the hierarchical levels are nested one within the other (customer hierarchy with firm hierarchy, competitor’s hierarchy with firm hierarchy…). For a given firm, dealing with growth in such a complex context represents a complex problem. A problem is complex when an explanation of its associated behavior
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requires several disparate levels to be addressed simultaneously (Ahl and Allen 1996). Then, low-level details in complex systems exert an influence over high levels and affect the behavior of the whole system. The problem of growth strategy in such an oligopoly requires taking account both fine-grain details and aggregate behaviors from inside and outside and consequently multiple levels of organization are needed to provide us with a solution. According to the Hierarchy Theory, the complexity is a function of the model embedded in the question, not of the material system itself. A system is defined as hierarchical if it can be described as composed stable subunits, unified by a super ordinate relation but the different levels delimitating the subunits are relative to the observer. What matters in understanding complexity comes from the relationships between levels and the relationship evaluation is observer’s dependant (Ahl and Allen, 1996). We aim to describe the super-player as the player able to create instability of a given complex system and as such able to drive two possible outcomes: either the system collapses to a low level of organization; or alternatively a new set of upper-level constraints emerge and the system moves to a higher level of organization. Here are embedded as sources of instability, evolution and revolution, change in objective laws or in subjective rules, sometimes at the same time. “Laws” capture the dynamical aspects of the phenomena, structure-independent, whereas “rules” are local and structure-dependent (Patee 1973). To a certain extent, the super-player is able to create disturbance within the complex system, either by changing the structure of the given system or by modifying the behaviors of the entire system players. We aim to describe this possibility either as a stone falling into the water and creating subsequent waves, or as a bubble emerging on the surface of the water. The super-player tends to simplify the current, embedded model by not filtering information and by enhancing nested ness within the ordering principle of the multilevel-system. The closing remark of ‘bigger bigger picture’ as a strategic mindset (Brandenburger and Nalebuff, 1996) tends to find a solution through this super-player’s behavior. Within a hierarchical organization, information is filtered from the lower level to the upper level in three possible ways: attenuation of the signal, delaying and integration/averaging. Considering current MNE’ sales structures, we can see the following organizational hierarchy:

Level 1 Customers

<table>
<thead>
<tr>
<th>Relationship Focus</th>
<th>Product Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service/Post-sales Focus</td>
<td>Level 2 Bis Modality specialist</td>
</tr>
<tr>
<td>Level 2 Account Manager</td>
<td>Level 2 ter</td>
</tr>
<tr>
<td>Service Account Mgr</td>
<td></td>
</tr>
<tr>
<td>Level 3 Zone Sales manager</td>
<td>Level 3 bis Modality Leader</td>
</tr>
<tr>
<td>Level 3 ter Service Manager</td>
<td></td>
</tr>
<tr>
<td>Level 4 Country Sales Manager</td>
<td>Level 4 ter</td>
</tr>
<tr>
<td>Country Service Mger</td>
<td>Level 4 bis Modality Leader</td>
</tr>
<tr>
<td>Level 5 Regional Sales Manager</td>
<td>Level 5 ter</td>
</tr>
<tr>
<td>Regional Service Mger</td>
<td></td>
</tr>
<tr>
<td>Level 6 Pole Sales Manager</td>
<td>Level 4 Bis Modality General Mger</td>
</tr>
<tr>
<td>Pole Service Manager</td>
<td>Level 6 ter</td>
</tr>
<tr>
<td>Level 7 CEO</td>
<td>Level 7 CEO</td>
</tr>
<tr>
<td>Level 5 CEO</td>
<td>Level 7</td>
</tr>
</tbody>
</table>
If we assume that the Chief Executive Officer (CEO) of a given MNC is responsible for formulating the growth strategy, then the numbers of levels between customers and the CEO represent as many filters to get the information about the unmet customer needs, source for future product or service. Moreover, by answering to these unmet needs, the CEO could decide to acquire some new capabilities or to develop them internally as we previously saw. New resources will be acquired or allocated and like a living system, the organization will grow and develop new properties. Association of new components provides customers with new collective sets with transformed information not resident in the previous components. The new information can only be read in a frame provided by often newly formed level of order. Consequently, aside from external complexity, derived from multiple technology paths, combined with geographic specificities, multinational companies in such technology-driven oligopolies add their own internal complexity. Growth adds complexity to an organization and this ‘internal’ complexity is sometimes difficult to manage (e.g. Penrose, 1959; Covin, Slevin and Heely, 2000).

Facing this external and internal complexity, the super-player, at a certain point, aims to simplify the different levels by “ignoring” the current hierarchical levels of the industry and its own levels. As such, the super-player’ status does not imply full predictability of success in the long-run because by essence, predictability in complex systems is achievable if only many levels are taken into account, while the super-player’ strategy is just the opposite by “over-simplifying” the levels within the oligopoly. By simplifying the problems they face, managers can bring problems within the bounds of their processing power and possibly come up with effective solutions (Simon, 1991). We tend to acknowledge that these business solutions belong to a more aggregate level of understanding business strategy. If we consider that the business technology-oriented oligopoly as a game with pre-defined objective laws like competitive fairness, free trade and technology bets available for everyone, then, each player of this game may sooner than later copy or implement the best practices coming from the other players. Schumpeter (1934) stressed that successful innovations/enterprises are threatened by swarms of imitators, all striving to produce ‘me-too’ substitutes. However, this condition –writing new set of subjective rules– is not sufficient to win: the source of the new rules really drives coming successful attributes of the new set. Players may develop tendency to internal focus (meeting profit’s expectations from shareholders), rather than listening to customers, who drive some of the coming attributes. Moreover, the way to implement the new rules within the organization adds another layer of complexity, which tends to be as important as the formulation itself.

These complex independencies within organizations have been studied with respect to evolutionary and ecological perspectives (Nelson and Winter, 1982; Hannan and Freeman, 1977) which have been applied at many levels of analysis (Baum and Singh, 1994). We ground our model in the evolutionary framework of variation, selection and retention (Campbell, 1969; Nelson and Winter, 1982; Anderson and Tushman, 1990; March, 1994; Van de Ven, 1992). Burgelman (1994, 2007) has shown that this evolutionary model can serve as a general framework for strategy process research: autonomous and induced strategic initiatives operate together to create the variation that the selective system operates on. In Burgelman’s model, the key role of the top management is to act as a selection filter, through resource allocation, even if top management actions are severely constraints (March and Simon, 1958). In our model,
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we suggest that the experiences of the super-players, coming from a right filtering effect, create enough variation in the system to influence the entire industry, i.e. the other players: they replicate the same experiences as if it was a natural selection environment. As the super-player evolves in his strategic choices, the industry as a whole evolves and the other players adopt sooner than later this evolution. This model provides a link between emergence of super-players and succession of super-players by its focus on co-evolution of players within an oligopoly. At the start of a time period, the super-player evolves in a disruptive way, creating variation in the complex oligopoly system. This variation is selected and adopted by the other players, as a consequence of the co-evolution between super-player and other players. Then, another player may evolve in a disruptive way, becoming then the super-player, creating a succession of super-players as shown in Figure 1.

3 A Case Study: Healthcare Medical Imaging Device Industry

In this section we will give a detailed description of a case of business oligopoly, namely, Healthcare Medical Imaging Device Industry to discuss relevance of our framework shown by Figure 1 to dig out some relevant insights about the industry.

3.1 Healthcare CT Players

Looking at the official firm background of the top medical imaging manufacturers, we find a commonality in terms of mission statement and the international dimension of their operations.

- About GE Healthcare “GE Healthcare provides transformational medical technologies and services that are shaping a new age of patient care. Our expertise in medical imaging and information technologies, medical
diagnostics, patient monitoring systems, [...] is helping clinicians around the world re-imagine new ways to predict, diagnose, inform and treat disease"

- About Siemens Medical Solutions: “Siemens Medical Solutions, with headquarters in Malvern, Pa., and Erlangen, Germany, is a healthcare technology innovation leader”

- About Philips Medical Systems, “[...] Today, Philips Medical Systems is a global leader in diagnostic imaging systems, healthcare information technology solutions, and patient monitoring and cardiac devices.”

- About Toshiba Medical: “[...] Today, Toshiba's focused offering of imaging technology continues to save lives and improve the health of people around the world with some of the most powerful and patient-friendly systems available”

At least three out of four MNEs claim being “Leader” in their market place, which tends to be unrealistic or biased. We plan to use as “grain” the behavior ofComputed Tomography Manufacturers, even if these MNEs design and manufacture other devices within the Radiology Department. We aim to study the behavior of these MNEs, comparing them to each other, due to the specific concentration of players in such an industry, while the possibility of new comers and the risk of substitution do not exist. The choice of the Computed Tomography product line is linked to specific reasons from a methodology standpoint:

- Among all the product lines of the various medical devices makers, the Computed tomography is a fairly new product line, originated in 1970’s and has been developed mostly internally by the main device makers,

- The CT product line of the four main players has not been impacted by any major acquisition, which helps the author to isolate the organic growth strategy effect for this specific Product line Vs other product lines (Conventional radiology, Magnetic Resonance Imaging…) and as such, the innovation path chosen by each manufacturer,

- The CT product line is considered as a mainstream medical device, distributed globally and used all over the world from the low-end CT (mono-slice CT) to the high-end medical equipment (64-row detector CT and above), which aims to provide us with relevant findings, rather than just “anecdotes”.

3.2 Growth strategy within the CT Oligopoly

In such a new technology-dominated industry where group of buyers interact with limited players, to acquire the same complex type of system, several business characteristics surface:

a. Willingness of each player to gain market share, while the CT market growth tends to slow down under the local budget constraints (in terms of reducing both the reimbursement rate and the volume of procedures)

b. Incompleteness of information for each of the players in a competitive environment tends to get a specific meaning in this industry, where
physicians get access to various CT systems, while working and while attending Radiology congresses (ECR, RSNA, Arab Health, Japan Radiology Congress…). In such a open information context, we aim to assume that each player knows at least the next CT generation projects from the competition.

c. Moreover, manufacturers deliver privileged information to their “opinion leader” customers in order to retain them and to ask them validating from a clinical standpoint any technology innovation. Manufacturers create local, regional or global “show sites” where the CT system operates in optimized conditions, under the leadership of opinion-leader radiologists, in well-known hospitals and clinics, creating a “word-to-mouth” marketing effect. For instance, Siemens Medical Solutions develops strong relationship with Prof. Kalendar at the Erlangen-Nueremberg University Hospital, Germany and at the Mayo Clinic, Rochester, MI,USA, while Ge Healthcare Europe actively supports the “Centre cardiologique du Nord” (CCN) in Saint-Denis, France, where operates Dr. JL Sablayrolles, pionner of the CT cardiac imaging. Toshiba Medical Systems intensively uses the medical expertise of the Keio University Hospital in Tokyo, Japan to test their new CT systems.

d. If at the beginning of the industry, simple specifications were the key technology differentiators (number of detector, acquisition time, reconstruction time…) of simple CT systems, the mutiple choice of new technology applications combined with the versatility of the CT system in the daily medical practice aims to complexify the possible offering and as such the strategy formulation for CT manufacturers: what technology should they push? Where and how should they sell it?

Based on these business characteristics, growth in terms of market share/revenues for each player relies on perceived differentiation compared to the other players, while external growth by acquiring a competitor is not an option for regulatory and financial reasons (each of the four MNEs are not “on sale” and their respective market capitalization discourage any taking-over from anyone). To achieve this perceived differentiation, the CT oligopoly faces emergence of new behaviors, along the time.

3.3 Emergence of new behaviors of CT Players

- Emergence of new CT systems: Product innovation

Considering the high technology content of a CT system (X-ray tube, power generation, detector type, reconstruction engine…), the “classic” perceived differentiation has been the Core CT Product Innovation path: every year, at the RSNA (Radiology Congress of North-America Radiology Society), in Chicago, USA, more than 60,000 radiologists, radiographers and radiology manufacturer employees converge to the Mc Cormick Hall to see the latest innovations, show-cased through academic publications and on-the-booth demonstrations. In November 2003, while the whole radiology “community” knows that each CT manufacturer did work on the next generation of CT, so called 64-slice CT, no one before the show could bet about any announce ment for CT manufacturers because just three years ago, the entire industry
did adopt the 16-CT system as the standard device, booming the CT market: for the first-time ever, since 2000, it was possible to scan fast and with high-resolution.

However, the evening before the official RSNA opening date, Siemens Medical Solutions did remove the sticker of their 16-slice gantry on the booth, by a new “64-slice CT” sticker: it was the fastest and smoothest upgrade in the Medical Device Industry! At that time, the only existing product as a prototype in the Siemens research center became for the customers a real product, only available from this particular player, while the other players were perceived as left behind. During the days of the show, Siemens Medical Solutions did capture the attention of the whole community, creating a “buzz” in terms of new specifications and new clinical applications. Difficult then for the other players to claim, on their respective booth, the title of “Technology Innovation leader”, when showing 16 slice-CT gantries and 16 slice-CT images.

In November 2004, just twelve months after the “soft” launch of the 64-CT system by Siemens, at the RSNA, all the CT manufacturers were demonstrating their own 64-CT systems with clinical images coming from their respective show-sites, playing each of them on their relative CT-system strenghts and highlighting the limitations of competitor’ system. In such a case, technical specification war and complexity of offerings emerges. For Siemens, the new “64-slice CT” announced in 2003 was in reality, specification wise, a 32-row detector CT system with a flying focal spot, creating “simili” 64-slice images. For Toshiba, the 64-CT system got the best specifications but its reconstruction engine and the clinical applications were outsourced to a third-party vendor, Vital Images, creating some limitations. Philips Medical Solutions used an inspired Marketing campaign, re-branding their product line with a “Brilliance” name, announcing both 40-slice and 64-slice CT systems. GE Healthcare pushed a concept on “Volume CT” with their 64-slice CT, claiming a complete volume image of the heart in “a heartbeat” (less than five seconds acquisition time), showing images processed by Dr. Jean-Louis Sablayrolles.

Despite other CT manufacturers’ efforts, Siemens was perceived by the CT Community, for at least 12 months (from November 2003 to November 2004) as the CT Product Innovation Leader, allowing him to “freeze” the CT market for the lowerspecification CT systems and to get pre-orders from customers. But in November 2003, from a technical standpoint, each CT manufacturer was, more or less, at the same level of development (prototype) and the only difference between Siemens and the other players was the player’s behavior. For instance, Siemens announcing its 64-slice CT did create an important short-cut, by-passing its internal levels and the external levels of its given industry (no prior clinical trials, no prior show site visits…) and simplifying the “launch” (no marketing collaterals, no real gantry).

- Emergence of new Clinical Applications: Value-added feature creation

Possible consequences of business strategy decision are provided by the real understanding of customer expectations, which tends to move the player focus from an internal perspective (how to grow my revenues?) to an external focus (what are the real needs of my customers?). Since 2001, French University Hospital La-Pitie Salpetriere did make the decision to install their GE 16-slice CT, not in the radiology
department but directly in the emergency department: the fast acquisition of a large set of anatomical structure appeared to secure the vital diagnosis of poly-traumatised patients, coming from the south of Paris (more than 250 poly-trauma patients are treated on an annual basis at this hospital). An unique medical expertise was consequently built between radiographers, radiologists on-duty and emergency doctors: for instance, to “save” broken vertebral spine nerves, the “golden hour” guideline has to be strictly followed between the accident and the surgery. After this 60-minute timeframe, there is unlikely no chance to get the spinal nerves working and as such, patients encounter high paralysis risk. Each minute counts for poly-trauma patient: vertebral spine assessment, Pulmonary embolism diagnosis, internal bleeding, pleurothorax, aorta dissection, heart failure, all life-threatening causes need to be properly diagnosed and treated in a very limited amount of time.

From 2001 to 2004, Dr Catherine Beigelman and her staff developped step-by-step settings of the CT system with pre-defined acquisition protocols and reconstruction views, routinely used when receiving a poly-trauma patient. GE Healthcare using this site to promote their 16-slice system rapidly acknowledged the unique value of tailored settings for specific clinical applications and decided to support further IT development on this clinical CT-based Emergency application, in close relationship with Dr Beigelman. Moreover, with the coming 64-slice CT system, scanning time could be reduced to 10 seconds from head-to-toe. Combining pre-defined protocols dedicated to Emergency and available technology, in 2004, GE Healthcare claimed having unique clinical Emergency CT-based applications and used La Pitie-Salpetriere as a show case. In 2004, the biggest Trauma center in Sweden, Karolinska Hospital in Stockholm acquired two GE 64-slice CT systems, based on this unique value; in Lausanne, Switzerland, Prof. Pierre Schnyder, radiologist and key developer of Emergency Radiology, did ask for the installation of a GE 64-slice CT system in the Emergency Department of the CHUV (University Teaching Hospital of Lausanne), based on the promising clinical results of the new protocols.

Carefully listening to main customers drive new behaviors within a player’s organization: the player completely reverses the perspective, where the customer acts as a partner and even as a co-player; in this case, the player designs the right solution, based on the co-player’s requirements and not from internal filtered limited information or assumption.

- Emergence of new Services: Service Innovation

Having CT systems in Emergency departments drives as well new behaviors from customers in terms of service. The players have to cope with these new behaviors, by creating services in line with the level of expectations of customers. All the players have developed a large set of services, after the one-year standard warranty: high-technology devices like CTs require regular maintenance, from X-ray Tube failure to IT debugging and this service brings a large stream of revenues and profit to the players, as well as a good retention tool. Service contracts, even renewed every year, tend to last the lifetime of the product and due to the large variety of customers, service contracts have been tailored according to the customer needs: labor only, parts only, parts and labor, 24 hour support on 7 days a week basis...
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However, the service implementation varies by player: Toshiba Medical Solutions sourcing their CT systems from Japan uses the high-quality standards to offer two years of warranty, free of charge. Such a statement carries several consequences: the total cost to serve calculated by the customer significantly decreases and the perceived differentiation is centered in Quality of product/Reliability. Service becomes a strategic weapon against the other players. When Siemens Medical Solutions operates under the same leadership team CT equipment and Service, they tend to consider some possible offensive trade-offs where they can slightly reduce the acquisition price and still make an overall profitable business in the long run. GE Healthcare organized under a clear segmentation between CT sales and CT Service, to maximize the profit at the customer level, may be perceived at the most expensive vendor by the customers.

4. Discussions

Our study contributes to validate our theoretical framework, with respect to the resource-based growth approach, in a number of ways. First, we begin to reconcile the concept of ‘growth strategy’ with the classic way of considering growth as market and product expansions logics. The super-player reduces growth strategies to product/service and market logics and such a strategic choice incorporates evolution of firm’s organizations. More surprisingly, this organizational evolution consequently drives the entire industry evolution. Second, our study recognizes the relationship between growth logics and resources to generate growth: the total amount of resources is not equivalent to the pool of resources a firm has at its disposal to fuel growth, a fact recognized by Penrose (1959). The super-player drives growth logics, even in a shortage of resources. Some scholars have argued that growing firms require increasing amounts of resource inputs. Other have suggested that growth brings with it increasing administrative complexity. Our results add yet a third explanation for the difficulty of a given player to grow in a business complex oligopoly in that strategic move is correlated with the creative capacity of top management to bringing new actionable solutions to complex problems. Our data suggest that this interaction is a function of selecting the kind of growth that is being pursued with retaining focused dedicated resources. Third, complexity of business strategy decisions aims to located not only in the number of parameters to be taken into account at a certain time (present complexity) but much more in the possible consequences of a given business strategy decision (prospective complexity). We have in mind the previously described business cases, where an one-time event (‘sticker on a gantry’, ‘An Emergency doctor in Paris’...) drive important business consequences, typically found in complex system theory where fine-grain details influence the system as a whole (“Butterfly effect” by Lorenz, cited by Gleick, 1987). Fourth, our study strongly supports the evolutionary dynamics of economics: evolutionary change processes operate on a firm strategy in that it may be suggested (variation), it may be changed (selection), it may exist over several time periods (retention) and a firm has to choose one strategic intent among several possible (competition). Finally, our study argues that intraindustry competitors, same players within a business technology-driven oligopoly, hold a common pattern of beliefs or schemes, influenced by the super-player itself and co-evolving with him. The underlying economics of an industry face industry players to accept a reality they might not have enacted on their own. Our model suggests interaction between managerial cognition and competitive factors and retains the salient aspects of bounded rationality (attention-constrained agents), managerial
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cognition, while including competition, strategic choice and the evolution of the industry structure. Our result demonstrate how competitive factors and bounded rationality together influence managerial beliefs, growth strategy and intraindustry variation. We find that industry-specific factors coming from the super-player and bounded rationality force other players to focus their attention on nearby competitor, the current perceived super-player. Focused attention means that firms do not consider a full range of ‘available’ information. This causes firms to develop biased estimates of their competitive environment. Since this interaction is reciprocal, firms’ estimates correlate with the estimates of nearby firms. Thus, because they observe each other, cluster of firms in a given oligopoly have similar beliefs. Managerial beliefs tend to converge, with the exception of the super-player’s behavior. Our data suggest a behavioral model of strategic choice wherein imitation drive strategic decisions of the standard players, while the super-player observes other firms and deduces appropriate disruptive choices, without considering the beliefs shared within the industry.

Applying our theoretical framework provides us with three meaningful insights about this specific industry: (i) the limits of managerial rationality and the importance of representations in complex systems; (ii) growth as a disruption factor in complex industry; (iii) the ‘entrepreneurial ambition’ as the source of disruption.

First, discovering an effective competitive position in business oligopolies is a necessary but difficult task for top management of a firm. Positioning scholars emphasize the role of deductive reasoning and rational choice in the origin of positions (Porter, 1980). In contrast, evolutionary theorists highlight the bounds of individual rationality and posit that effective positions emerge through a mix of luck and experiential, local search, thus leaving little space for the cognition of managers (Nelson and Winter, 1982). We tend through our model of growth strategies to recognize the limits of managerial rationality and the intelligence of local search. Bounded rationality suggests that thinking is typically premised on simplified cognitive representations of the world (Simon, 1991). As boundedly rational actor, the super-player create cognitive simplifications of their decision problems and come up with solutions on the basis of such simplification. These actionable solutions, in turn, may imprint subsequent efforts at local search, playing as such a central role in the discovery of strategic positions (Gavetti and Levinthal, 2000). This perspective represents a middle ground between positioning and evolutionary arguments. The super-player behavior suggests that the roots of superior competitive positions may lie in the management cognition, in the way they represent the world. Our conceptual model of super-player finds its validation in business complex evolving oligopolies: in such settings, we conclude that a large number of underlying characteristics of the complex system drive the relationship and the interaction between firms. There are so many characteristics and their effects are so difficult to discern that the boundedly rational super-player focus its reasoning efforts on a subset of the characteristics. These subsets form representations, i.e. classifications schemes. An effective scheme puts similar objects in the same class and different objects in distinct classes. The super-player acts as an observer of a hierarchical system. Armed with an adequate representation of the world, the super-player is well prepared to draw a solution and apply it to a target sector. Our framework applied to the CT Industry shows the best performance among firms with adequate representation of the business world, at a certain point of time.
Second, in examining the role that strategy plays in firm growth, researchers generally have either relied on positioning generic business strategies (Porter, 1980) or have employed technical innovation related strategies based on specific capabilities. Penrose (1959) viewed the growth of the firm as comprising the double-sided problem of diversifying into new products and new markets within the constraints of a firm’s current pool of available resources. Growth brings with it greater organizational complexity and the difficulty of managing complexity is at the heart of the Penrosian growth engine since it is assumed that such complexity taxes available resources beyond their capacity, thus slowing firm expansion. By reducing the strategic problem of growth down to its most elemental product and market dimensions, the super-player substantially reduces the organizational complexity. One way of framing such finding is to consider firm’s underlying business routines. Since March and Simon (1958), scholars have viewed organizations have viewed organizations as bundles of behavioral routines that are enacted as ‘programs’ when triggered by internal and external stimuli. Nelson and Winter (1982) have expanded this argument to organizational growth by conceptualizing growth as a change in an organization’s existing routines. In their words, ‘just keeping an existing routine running smoothly can be difficult’ (Nelson and Winter, 1982: 112) and managers spend a significant portion of their time struggling to keep an organization in conformance with its routines. Since, in Nelson and Winter’s viewpoint, growth entails the replication, addition, or recombination of existing routine, growing a firm is an order of magnitude more complex than merely operating the firm in a steady state. The added complexity is due to the disruption of the tacit coordinating mechanisms that have evolved to bind a firm’s routines within the boundaries of its existing businesses. In that respect, we argue that the super-player uses this disruption as a factor of growth, by exporting this disruption outside its firm’s routines and inside the industry, consequently transforming the industry routines.

Third, the motivation to transform its routines quickly onto growth and consequently to transform industry routines is rooted in what Penrose called the ‘entrepreneurial ambition’ of the top management team: management ‘s desire for growth and its appetite for taking risks to ensure growth occurs. Managers will seek to extract growth from resources immediately. Resource-based conceptions stress the importance of resource slack as a driver of growth rather than the total quantity of resources possessed by a firm (Penrose, 1958). Slack is the dynamic quantity that represents the difference between the resources currently possessed by a firm and the resources demands of the current business. For entrepreneurial managers, slack is ‘waste’ and they are willing to endure short-term deficits or negative slack in order to promote futur growth. (Siemens ‘launching’ new product without marketing colletterals, just a sticker in our study). Risk takers have the confidence to assume that the missing elements of the pattern will not compromise the entire strategic move. Such deficit-driven growth is obviously not sustainable in the long run. But in the short run, this risk taking decision gets some pay off by disrupting the industry established routines.

In addition to the above theoretical contributions, the study suggests several potentially fruitful directions for future research. First, additional studies are needed to explore the generality of our results over longer periods of time and in subsequent complex industries (Ultrasound, Magnetic Resonance for instance). The possible difference between short-term and long-term patterns of growth as emerging strategic
moves is a complicated issue, both conceptually and methodologically. On the one hand, it is tempting that growth strategies and their interactions with the industry can only be evaluated in the long run, as the pattern of growth unfolds over the time. On the other hand, growth is an ongoing and instantaneous phenomenon and resource deployments are made in real time according to short-term feedbacks, based on the emergence of super-players in a given industry. This suggests that patterns of long-term growth are primarily aggregations of short-term decisions and our focus on short-term strategy and actionable solutions is not only appropriate but preferred. Adjudicating between these two interpretations of our results will be possible only with the collection of cognitive data over a longer time period with a cross-sectorial approach. Second, while our arguments assume that complexity serves to emerge super-players in a given technology-oriented oligopoly, we may expand the model of emergence of super-players to any kind of oligopolies. To explore this issue further, we may consider other oligopolies where limited players search for competitive positions and we may correlate the number of players with the level of complexity to determine the possibility of super-player’s emergence. A possibility we do not model, worthy of future research is to track more thoroughly the interactions among growth logics, number of players involved and level of complexity within a given industry. Our conjecture will be to assume that the larger the number of players is, the more difficult the occurrence of finding super-player able to influence a given industry is.

Third, future research might be useful to examine more deeply the interdependence between strategic choice of a firm and implemented actionable actions in complex evolving oligopolies. The choice of a particular approach for higher-order strategy typically has an influence on detailed choices. A type of interdependence that Simon (1962) has labeled near-decomposability. Finally, what emerges as well from this super-player’s framework is the question of sustainability of the super-player, due to the co-evolutionary dimension in business technology-oriented oligopolies. Further theoretical work is needed to tighten the framework and empirical research may be critical to validate such a model in other business technology-oriented oligopolies.

5. Conclusion

This research investigates the relationship between strategic choice, managerial cognition, complexity of business oligopolies and industry evolution. Drawing upon economics, strategy and complexity science literatures, we have constructed a model that can explain the emergence of a certain type of players in a complex evolving oligopoly. This study suggests that these findings can be explained as being a result of the interaction of the cognitive processes of bounded rational strategy makers with the underlying economic structure of their industries. Bounded rationality in and of itself cannot explain why managers will develop a different set of beliefs for developing new strategic choice, within a given industry; it is only under the co-evolutionary conditions that managers will come to hold different cognition about their industry.

More broadly, cognition in complex worlds inevitably involves simplification. The precise basis of simplification is our condition of bounded rational individuals, which limits us to think in high-dimensional spaces. The relevant question, for strategic makers in business complex evolving oligopolies, is not whether we conceive of complex strategic problems in terms of few general variables but rather what those variables will be. Our hope is that rigorous analysis of managerial cognition in business complex environments will help bridge the distance between the behavioral,
evolutionary approaches on strategy with the system theory. Understanding how firms identify effective strategic positions in a complex world requires both perspectives. With the current work, we try to provide some substance of that link and a model on which we can build.

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Emergence of super-players in Healthcare Computed Tomography Oligopoly


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AUDIT SUPPORT PLUG-IN SYSTEM BY THE USE OF ONTOLOGY MODEL

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ABSTRACT
Auditing against Generic Management System requirements, like requirements of ISO 9001, is an established means for evaluating organizational capabilities. In ISO 9001, auditors check individual management system based on generic management system standards. Auditors faced with semantic problems because they must interpret the meaning of individual complex management system from the stand point of generic management system standards. To solve this semantic problem, audit support system has been developed using ontology editor. However the audit support system is not widespread, because the ontology editor is so complex. In ontology editor Protégé, too many functions for the ontology operations are provided. The main objective of this paper is to develop a new audit support plug-in system, which supports auditors who don’t know about ontology concepts will be able to solve the semantic problems. In this paper, first we analyze complexity of conventional audit support system. Next, we construct plug-in system that is customized in audit by the use of Protégé plug-in function.

Keywords: ISO, audit support system, Ontology, plug-in, Protégé API

INTRODUCTION AND MOTIVATION
Auditing against Generic Management System requirements, like requirements of ISO 9001, is an established means for evaluating organizational capabilities. ISO 9000 family is a set of standards for Quality Management Systems (QMS). ISO9000 family includes ISO9000 (basic terminology), 9001 (QMS Requirements), 9004 (guidance for improving performance), and 19011 (audit guidance). To acquire the ISO9001 certification, organizations have to receive third party audits. Auditors check QMS of auditee (the party receiving audit) with ISO9001 requirements. However there are 2 problems. One problem is that Management system standards are too general to be applied effectively, because ISO9000 family is defined abstractly to apply varied sizes or types of organizations. Therefore it’s not easy for auditors to understand the management system standards, and then audit conclusion may be changed. The other problem is “Lack of understanding QMS.” Individual QMS is complex information system which has a lot of variation, so it’s not easy for auditor to understand the auditee’s QMS too. The main audit activity is to check auditee’s QMS. Therefore it’s necessary to understand and share auditee’s QMS correctly between auditors and auditee.

Ontology is studied as a knowledge acquisition method in the artificial intelligence field in recent years. Ontology can systematically classify everything that exists in the object world, define the relation of the vocabulary by property, and be able to describe meaning of the vocabulary and the relation. Using ISO9000 family ontologies, auditors can prevent misunderstanding. Gehrmann et al. (Gehrmann, 2005) constructed audit ontologies called AuditOWL using ontology editor Protégé. AuditOWL has ISO9000 ontology, ISO9001 ontology, ISO19011 ontology, and audit meta-ontology. Audit meta-
Audit Support plug-in system by the use of ontology model

ontology is ontology in order to construct auditee’s QMS ontology. Applying auditee’s QMS to ontology, auditors can come to understand QMS correctly. ISO ontologies can enable interested parties to put abstract ISO concepts and requirements and to establish a wider ontological commitment, and can so contribute to more effective auditing by prevention of “interactive waste.” Furthermore it’s enabled auditors to audit consistently by cross-referring ISO ontologies and auditee’s QMS ontology. Furthermore QMS ontology can share by using ontologies shareable over network, e.g. the Internet. AuditOWL supports auditors. However the auditors must understand ontological concepts for using AuditOWL. And Protégé has a lot of functions and complex interfaces. The problem is that the difficulty of Protégé’s usage. The main objective of this paper is to enable auditors without ontology concepts to perform audit activities with AuditOWL system. Protégé provides plug-in function and a Java-based Application Programming Interface (API) for building knowledge-based tools and applications. We develop Audit Support Plug-in which supports “Auditing with AuditOWL” and improves AuditOWL’s usability. In this paper, we explain “Auditing with AuditOWL” and the problems, and then we propose Audit Support Plug-in.

AUDIT ONTOLOGIES

The Problems about QMS Audit

ISO 9000 family is standards for quality management systems. ISO9000 family consists of 4 core standards, ISO9000 (fundamental and vocabulary), ISO9001 (Requirements), ISO9004 (Guidelines for performance improvements), and ISO19011 (Guidelines for Quality Management Systems Auditing). ISO9001 is the only standard for certification. The organization can provide continually the products or services of an excellent quality operating the certified QMS. Auditors audit organizational QMS comparing with ISO9001 requirements. In auditing, the following 2 problems are discussed (Gehrmann, 2008).

- terminology problem
- audit complexity problem

ISO 9000 family defined abstractly because ISO 9000 family was revised for applying varied types or sizes of organizations in 2000. As a result, it’s not easy for auditors to understand the management system standards, and then audit conclusion may be changed. This difficulty called terminology problem. Auditors need to understand ISO 9000 family standards correctly. Lack of understanding of auditee’s QMS is also audit problem. The varied sizes or types of QMS which constructed by auditee is complex information system. Therefore it’s not easy for auditor to understand auditee’s QMS too. Auditors may points out an irrelevant thing. Gerhmann (Gerhmann, 2008) calls this problem “audit complexity problem.” Auditors and auditee should have common understanding about their QMS, and auditors should lead an accurate audit conclusion.

Currently computer assisted auditing techniques like web meetings, interactive web-based communications and remote electronic access to the documentation and/or processes are considered for enhancements of audit effectiveness and efficiency. These types of techniques are considered to increase the efficiency of audits in terms of time saving and cost reduction. However above-mentioned issues are not yet addressed.

Audit Support System Using Ontologies Called AuditOWL

2
Audit Support plug-in system by the use of ontology model

Ontology is studied as a knowledge acquisition method in the artificial intelligence field in recent years. Several definitions of ontologies are commonly used. T. Gruber (Gruber, 1993) defines ontologies as agreements between shared conceptualization. Ontology is used for the definition of the concepts and the relationship among concepts.

To solve the audit problems, Gehrmann et al. (Gehrmann, 2005) constructed audit ontologies called AuditOWL using ontology editor Protégé. AuditOWL has ISO9000 ontology, 9001 ontology, 19011 ontology and QMS meta-ontology. QMS meta-ontology is ontology to construct auditee’s QMS ontology. Auditors construct auditee’s QMS ontology using this QMS meta-ontology. Auditors and auditee can have the shared common understanding about the system concepts by defining the concept of QMS formally. And auditors can draw accurate and consistent conclusions from audits, by cross-referring QMS ontology and ISO9001 ontology.

The Problems of Conventional Audit Ssupport System

However the audit support system called AuditOWL is not widespread. There are the following 3 problems for AuditOWL.

Complex Protégé Interface
Protégé is a free, open source ontology modeling editor. Protégé can enhance the function using Protégé plug-in. On the other hands, Protégé has a lot of icons or tabs on the interface (Figure 1). So it’s difficult for auditors to operate Protégé intuitively. The easy input interface is needed.

Necessity of QMS Ontology Construction
Using AuditOWL, auditors can draw accurate and consistent conclusions from audits by cross-referring QMS ontology with ISO9001 ontology. To draw accurate and consistent conclusions, auditors need construct QMS ontology. However all auditors do not necessarily have ontology knowledge. It is difficult for auditors who don’t know ontology concepts to use this system. The device that doesn’t need to require ontology concepts is necessary.

Complex Use
There is a “complex use” problem as a cause to which AuditOWL isn’t widespread. Figure 2 shows the interface that appears when auditor checks requirements of management systems. For example, to check “Control of monitoring and measuring devices”, the auditor need select “Product Realization” class from too many classes. And then auditor selects “Control of monitoring and measuring devices” instance from the right side. AuditOWL has 364 classes about audit. When auditors make some instances from specify class or give the slot values, user will be puzzled. Protégé has a search functions, but the beginner user doesn’t know class name or property name. The structure to navigate input for beginner user is required.
Audit Support plug-in system by the use of ontology model

Figure 1. The Protégé Interface

Figure 2. The Interface that Appears When Auditor Checks Requirements of Management Systems

We think that the following things may solve the 3 problems above.

- Easy interface to input
- Do not require the ontology concepts to auditors
- Navigating mechanism for input
Audit Support plug-in system by the use of ontology model

We try to improve audit support system and solve the 3 problems.

AUDIT SUPPORT PLUG-IN
As a method of solving the problems of AuditOWL, it's conceivable that "Teaching ontology concepts to auditors" or "Constructing a new application which auditors can use easily." However "Teaching Ontology to auditors" costs a lot of money and time. Or if we construct a new application, the effectiveness of AuditOWL is lost. Meanwhile ontology editor Protégé provides plug-in function. Plug-in can be used to change and extend the functions of Protégé. We construct the plug-in with the function demanded from AuditOWL. Then auditors can use AuditOWL easier with the efficient of AuditOWL.

Development of Audit Support Plug-in
We try to develop Audit Support Plug-in which solves the AuditOWL problems. This plug-in doesn’t require considering ontology concepts to the users and settles the problems of AuditOWL.

Interface which is Specialized for Audit Activities
First, we design the interface which is specialized for the audit activities. We customize the interface so that auditors can input audit information in order (Figure 3). This interface supports to input audit information (like “audit objective”, “covered department” etc. Thus the problem of complex Protégé interface is solved. However, in this state, auditors can’t construct QMS ontology.

Figure 3. Interface which is Specialized for Audit Activity
Audit Support plug-in system by the use of ontology model

Conversion from Input Information to QMS Ontology
We try to consider a method to construct QMS ontology from audit information. We should consider auditors who don’t know about ontology concepts, so it is preferable to hide the ontology construction part from auditors. To hide the ontology construction part, we use Protégé API. The Protégé API is an open-source Java library. The API provides the classes and methods to load and save OWL (Web Ontology Language) files, to query and manipulate OWL data models, and to perform reasoning. For example “createInstance (String, Class)” method creates instance from a specific class. “setOwnSlotValues (Frame, Slot, Collections)” method sets values to specific slot of specific frame. To create “audit objective” instance and set the slot values, AuditOWL needs first select “audit objective” class from lots of classes, second click the “create new instance” icon, and third input the audit information as an slot value. On the other hand, in a new way of using Protégé API, the user only input audit objective to the prepared text field. When the user clicks the OK button, the audit objective instance is automatically made. Auditors who don’t know ontology concepts can construct QMS ontology. Thus the problem of necessity of QMS ontology construction is improved.

Navigation for Input
We should consider that auditors don’t be puzzled when they input audit information. In ISO19011, the 7 steps of typical audit activity are shown (Figure 4). Auditors perform the audit activities following this audit steps.

![Figure 4. Overview of Typical Audit Activities](image)

We re-customize the Audit Support Plug-in interface based on the typical audit steps. In the new interface, the 7 steps are arranged in order of audit steps at left side like menu bar (Figure 5). When the each button is clicked, each input form is displayed.
Audit Support plug-in system by the use of ontology model

Figure 5. The Interface Based on Typical Audit Activities

Thus auditors are able to input audit information without being puzzled. The navigating mechanism was able to be done and the problem of complex use. The problems "complex Protégé interface", "necessity of QMS ontology construction", and "complex use" of a past system were solved by "Introduction of the plug-in", "Use of Protégé API", and "Design of the interface based on a typical audit activity"

Table 1. Problems and Resolves

<table>
<thead>
<tr>
<th>Problem</th>
<th>Resolve</th>
<th>Use</th>
</tr>
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<tbody>
<tr>
<td>Complex Protégé interface</td>
<td>Use Protégé Plug-in function and customize the Protégé interface which is specialized for audit activities</td>
<td>Protégé Plug-in</td>
</tr>
<tr>
<td>Necessity of QMS ontology</td>
<td>Construct QMS ontology automatically from audit information using Protégé API</td>
<td>Protégé API</td>
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<tr>
<td>construction</td>
<td></td>
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<tr>
<td>Complex use</td>
<td>Re-customize based on typical audit activities and navigate the users.</td>
<td>Typical audit activities</td>
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Audit Support plug-in system by the use of ontology model

Table 2. Comparative Table between AuditOWL & AuditOWL with Audit Support Plug-in

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<th>AuditOWL</th>
<th>AuditOWL_AuditSupportPlugin</th>
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<tbody>
<tr>
<td>Auditor who knows about ontology</td>
<td>_ can use</td>
<td>_ can use</td>
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<tr>
<td>Auditor who doesn't know about ontology</td>
<td>_ can't use</td>
<td>_ can use</td>
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<tr>
<td>Interface</td>
<td>complex</td>
<td>Simple (only information about audit)</td>
</tr>
<tr>
<td>Manipulation</td>
<td>complex</td>
<td>Simple (only input information in the blank and click a button)</td>
</tr>
</tbody>
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CONCLUSION
The number of organizations that want to take certification of ISO9001 has increased aiming at the quality improvement of the product and service. To take ISO9001 certification, the organizations construct original QMS, and receive the third party audit. It is said that auditors have terminology problem and audit complexity problem in the audit activities. To solve these problems, Gehrmann (Gehrmann, 2005) constructed audit ontologies, and propose audit support system called AuditOWL. AuditOWL helps auditors to understand ISO9000 family and auditee’s QMS. And a consistent audit can be held by cross-referring auditee’s QMS ontology with ISO9001 ontology. However, in order to use AuditOWL, auditors need ontological concepts and to construct auditee’s QMS ontology. Moreover ontology editor Protégé has a lot of functions and complex interface, so it’s not easy for auditors to use AuditOWL. We developed Audit Support Plug-in that is specialized for audit activities. This plug-in system provides simple interface and simple use, and be able to construct auditee’s QMS ontology. To hide the ontology construction part, we use Protégé API. Auditors need to only input audit information to the prepared text field. Then they can construct auditee’s QMS ontology without ontology concepts. Furthermore they can lead audit conclusion correctly by cross-referring QMS ontology with ISO 9001 ontology.

REFERENCES
Audit Support plug-in system by the use of ontology model


Protégé Project website, http://protege.stanford.edu/
THE "COSMO-PLANETARY AND TERRESTRIAL META-DYNAMICS SYSTEMICITY"
AND “LIFE’S INTRA-BIODYNAMICS SYSTEMICITY”,
THEORIES RESULTING FROM
A “BIOETHISM’S TRANSDISCIPLINARY APPROACH”¹

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Abstract

Ever since 1996, J.-J. Blanc, as the author, made an extensive research on "Systems science", which induced to his developing a new systemic² paradigm in terms of a transdisciplinary approach to "Living systems" that he named “The Bioethism” (see note 1). It is meant to support the acquisition of a large understanding of living systems' origin, of the meaning of their natural structure and their adaptive behaviors, their bonds and evolution trends while permanently interacting with environmental events for survival. These actions-reactions from ago-antagonistic signals and stimuli within their body milieu, their ecosystemic and sociosystemic environments are closely linked with and affected by - a) their specific individual and social status and the diversity of species behavioral evolutionary trends - b) cosmo-planetary and terrestrial meta-dynamic forces.

The survey of the different scientific disciplines development concerned with the actual "Science of Systems", shows that the living systems' knowledge of reality is, for too many scientists, in developing their works in the strict philosophy of human "reason" (logic and metaphysics). Excepted, of course, are those disciplines where individual and societal emotion is a paramount understanding of pragmatic survival rules. An adequate learning for a sustainable development of societies, respecting the required survival diversity needs is here based on new general theories the author called “The general meta-dynamics systemicity" and "Life intra-dynamics systemicity” and "The general systemicity". Because they rely on the entire body of forces and dynamics that made and makes physicochemical moves to exist and sustain, by essence the biological ones, and behavioural processes adapting to the permanency of change. At the Life's level of survival intra-dynamics systemicity, the "cosmic"³ meta-dynamics of universal forces and moves participate in the physicochemical dynamics of the biological world of which systemicity is based on retroactivity building up a temporal sustainability.

¹ - Bioethism is a general humanistic transdisciplinary approach paradigm that I developed in 1996, which has shown the necessity to work on the knowledge of any living system's structure and behaviors as interacting within its environmental space and on its body milieu and ecosystem's niche levels, taking into account a general representation of species in terms of "Biology, Ethology-ecology - Humanity". The presence of man stresses the necessity to approach the livings survival fundamental values as common to all creatures' capacities to sustain and assume the protection of Life on Planet Earth: www.bioethismscience.org
² - Systemic (adj.): nature of a dynamic and retroactive process pertaining to or affecting an organ or the body of an organism.
³ - Cosmic: the essence of the general relativity is in the space-time lag that has a dynamic cause and its effect properties,
Meta-dynamics Systemicity

Consequently, an overview upon the entire body of universal interdependent biophysicochemical mechanisms, moves, processes and streams interwoven within "3D networks", shows that survival abilities and performances are epigenetically provided from both the convergence of cosmo-planetary forces (magnetic, gravitational…) and terrestrial conditions (geologic, geochemical, geophysical, geo-climatic…), which, retroactively, sustain the Earth and by extension the biological world of individuals and societal systems to exist and survive within a dynamic equilibrium inevitably interdependent of chaotic effects of the thermodynamic entropy.

My work, requiring several communications, it was decided to divide its development into different "scientific principles" chapters that support the complexity of cosmo-planetary and terrestrial meta-dynamics systemicity. Their effects are combining interactive physicochemical forces and moves, as emergent results generally referred to their synergistic, their dynamical coordination supporting the meta-drivers systemicity. A few paragraphs of will prepare another communication about "The Life's intra-biodynamics systemicity" and the provisional conclusion assumes the future description of the "Theory of a General Systemicity".

**Keywords:** Systemicity, Bioethism, dynamics, meta-drivers, synergy, cosmic physics, emergence.

**INTRODUCTION**

The purpose of the author is to bring up to achievement "new theories" based on dynamic forces and moves: - one about "The cosmo-planetary meta-dynamics and terrestrial systemicity" - the other about the dynamics of biochemical contexts as of Life to exist, developing living systems survival adaptations, named "The Life's intra-biodynamics Systemicity". They are in no ways meant to be "general systems theories", which is an obsolete approach of the so many systems' mechanism and intellectual casts of mind that express sides of human intelligence and creativity. RNA, DNA processes produced and still produce common behavioral abilities for survival to all species including man. The survival dynamics list is long such as feeding, dwelling, communicating, reproducing, escaping, building, reacting… as terrestrial forces and moves forming together with cosmo-planetary meta-dynamics the entirety of "systemicity". A notion that is a much precise and innovative overview of our univers since it is being a transdisciplinary approach meant to foster the realistic description of dynamic results. Emerging from pressures over the living systems' survival, those dynamics are interdependent with the actual completeness of the Universe ecosystems and include biophysicochemical structures and processes that induced living creatures to develop sustainability, adaptability and endurableness within cell's membrane and filtering reactors capable to perdure and reproduce for some time.

The "General systemicity", "The cosmo-planetary meta-dynamics and terrestrial systemicity" and "Life's intra-biodynamics systemicity" are "meta-drivers" with systemic specificities that show the complexity of imbricate and interrelated result emergences. They are differencing behavioral moves in one and other physicochemical fields as induced to by synergistic drivers producing one or another chains of specific effects.

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4. Dynamical: "of or relating to physical force or energy", 

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Meta-dynamics Systemicity

By way of consequence, it is postulated in this work that studying the primordial components of the living origin, and its evolution does require a large transdisciplinary mastership of the "Systemicity of those dynamics" that participated in Life to happen and of sciences of the living beings. The "Bioethism paradigm" was created at it.

This paper will describe only some aspects of "Systemicity" in terms of physics, chemistry and biology principles, given that actual scientific information is to illustrate postulates and realities of cosmo-planetary forces, processes and moves.

THE NOTION OF "SYSTEMICITY"

The notion of "systemicity" is related to the whole of primordial and dynamic moves, forces, phenomena and processes, which mechanisms are confronted with physicochemical interactions and reactions of elements, matter and energy. These systemic momentums emerge from interconnected, interrelated and interdependent moves within atomic and physicochemical elements that are submitted to the permanency of pressures, fractures and bifurcations occurring within cosmo-planetary environments: the cosmos, gas and dust nebulae, stars, galaxies, the solar system as well as planetary environments exchange their forces effects, named interconnectivity. The universal physical and chemical forces (magnetism, gravity, strong interaction, weak interaction, gas reactions and contextual changes...) are together constraining and beneficial to the Planet morphological and contextual evolution and to that of other cosmic objects. Further more, the notion of "Systemicity", appreciated in terms of the "drivers" it is composed of; is providing impulse or motivations, that show the notion of "cosmic velocity" is consubstantial in dynamics.

"Systemicity" is particularly explicit of the whole of physicochemical processes that have differential outputs, particularly those that have positive ago-antagonistic directions induced to the retroactive connectivity that sustain survival phenomena in general. Such sustainability is in no time a one way move, since successive outputs emerge in a synergistic environment from set of reactions and counteractions toward the permanency of the universality of the thermodynamic law, named entropy as balanced with physicochemical survival moves.

Living Systems Science And Other Human Creation of Systems

The necessity of a "large clarification of systems science", principally because there cannot be "a general systems science", or a "theory of system science", so much the "Systemics" actually developed apply to so many morphological and intellectual sorts of systems and a large confusion using the noun or the adjective "systemic". On Earth, an undisputed contextual situation is related to permanent changes of living events from feedback "retroaction differential results" that has induced me to search for "new

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5. Interaction: "action that occurs as two or more objects have an effect upon one another",
6. Reaction: "resistance or opposition to a force, influence",
7. Momentum: "force of movement; strength or force gained by motion or through the development of events. Also the product of the mass of a body of matter multiplied by its velocity (Physics, Mechanics)"

8. Counteraction: "to restrain or neutralize the usually ill effects of by means of an opposite force",
9. Entropy: "the unavailable energy in a closed thermodynamic system, a disorder status that varies directly with any reversible change in heat in the system and inversely with the temperature".
Meta-dynamics Systemicity

transdisciplinary fundamentals" so as to build up a scientific and realistic development of Life's systemic dynamics. In order to comfort the specificity of the "Living systems Science ", a global theory, I have called these new fundamentals the "Theory of Life's intra-dynamics systemicity", that some ones would probably like to read as of the "Theory of Life's systemic complexity".

Beyond the sense given to the noun (and adjective) “systemic” that are generally referring to qualify most "systems" in about 30 different meanings others than living systems, the notion of “systemicity” is, in this new theory, far more suggestive. Global and adequately dynamic, the sense of "systemicity", as we said, is only to refer to the dynamic sense of “velocity\(^{10}\)". However, these two notions are not to be understood as synonymous but yielding to the same connotation in terms of moving forces that participate in cosmos and Life to exist and sustain.

The neologism "systemicity" I have launched (Monterey CA, 2004), is also referring to "Life's driver dynamics" understood with "The Bioethism transdisciplinary approach paradigm" (Biology- Ethology, ecology - Humanism). It fostered universal specificities relative to the complexity of Life's processing as it appeared on Earth. Primordial systemic and dynamic phenomena were physicochemical moves of matter and energy, all of them being interdependent, interrelated and interactive with solar system forces and planet cosmic constraints serving survival to reproduce. Understood as a global terrestrial move, its "tick tock" induce intermediate ago-antagonistic circular swings from birth to death: the Life’s pendulum sways throughout the interconnected living system web and ecosystem networks. Thus, the determinant survival\(^{11}\) dynamics are transactions that are permanently confronted with physicochemical and cosmic periodical forces, pressures and opposite changes in environments and milieu metabolisms.

The Yin-Yang\(^{12}\) philosophy of two complementary forces, or “the principle of duality” as "opposing extremes”, that represents everyday Life's phenomena as ago-antagonistic rejoins my feeling about Life's systemicity, particularly while relating it to the role of space-time in the history of unconscious and conscious natural and cultural retroactions dedicated to behavioural action. "The everlasting rustle sound of the planet, the “Gaia's clock” echoes with creatures’ behaviors for survival, and the permanent change of things builds up their genesis and environments evolution (J.-J Blanc, 2004).

**The Cosmo-Planetary Dynamic Systemicity**

The Universe gradual evolution is a matter of primordial "neguentropy\(^{13}\) systemicity" due to the very slow transformation of the Universe. Over -12 billions years elapsed until the Earth was formed as a planet, and the arrival of Life at an early Archean period, around - 3.8 billions of years, is an authentic illustration of "an evolving historicity". It shows the much diverse type of dynamical phenomena:

\(^{10}\) Velocity: "the rate of change of position along a line and/or throughout a 3D network, with respect to time or the derivative of emerged positions with respect to time. It is also a rate of occurrence or action : the differential speed of historical changes.

\(^{11}\) Survival: "the continuation of life or existence".

\(^{12}\) Yin-Yang: between those two complementary forces, there are "in-betweens", e.g., there is a certain gap giving some distance in between the two opposites. In fuzzy logic, it means that at a point in between, one can evaluate the value that separate the point to one or the other opposite. It induced to the development of fuzzy-mathematics by Zadeh (note by J. Blanc 1997)

\(^{13}\) Neguentropy: "neguentropy is an organization factor in physical, biological and sociological systems that counteract the natural disorganization tendency" of elements, matter and energy.
Meta-dynamics Systemicity

- The high constraints of thermodynamics over cosmic objects, and its practical implementation,
- The universal force of gravitation that governs the motion of cosmic objects, all forms of matter, and energy,
- The retroactive effect that induce endogenous and exogenous status changes, while sustaining the formation and evolution of galaxies, star-systems planets and the effects on Earth's original, actual and temporal integrity,
- The high benefits of dynamical effects, in terms of an endemic balance, that maintain planets at distance from an early death,
- The high interrelations of the cosmo-planetary and terrestrial meta-dynamics, and their effect over Life's intra-dynamic systemicity,
- The evolution of gas composition of space and atmosphere that induced to the apparition of water, oceans,
- The retroactive moves due to atmospheric conditions that implemented a physicochemical medium and a synergistic context for Life to appear.

The universality of "the general meta-dynamics systemicity" notion is represented by numbers of retroactive processes that produce energy (thermonuclear, thermodynamic, physicochemical, solar, kinetics, radiant, gravitational, electromagnetic...). Their interrelated cosmo-planetary meta-dynamics effects, like stars and planets existence, are consubstantial with the terrestrial physicochemical circular ones on Earth. For a short example, let's mention the “climatic recycling” of vapour to water. For some of them, the chief part of Albert Einstein's imposing body of work is here quoted:

"Albert Einstein, between 1905-1915, developed a theory of relativity: the "electrodynamics of moving bodies" (the speed of light is a physical constant but a cosmic body never rest as continuing to move uniformly) and with the General relativity developed the "geometrical theory of gravitation". An act that unifies special relativity and Sir Isaac Newton's law of universal gravitation with an insight that gravitation is not due to a force but rather is a manifestation of curved space and time, this curvature being produced by the "mass-energy" and momentum content of the "space-time".

A first version of the theory of relativity (Albert Einstein, 1905) who did not consider the question of accelerations of a reference frame, nor "gravitational interactions" of the origin, was named “Restricted Relativity”. However, it presented a coherent explanation of the "electromagnetic interactions" and their transformations by change of reference frame using the transformation of Lorentz. Moreover, it solved paradoxes existing in traditional mechanics relating to the "measurements of the light velocity".

This theory introduced, then the concept of space-time and explained phenomena of the duration and distance variation measured by two observers, each one being located in a different reference frame. Experimentally checked, it has shown "results of retroactivity between these moves". The static Universe model developed by Einstein and the cosmological constant, lying at the crossroads of quantum mechanics and gravity is controversial since the Universe is on the move with gravitation attraction as assumed by Edmond Hubble (1929) discovering that galaxies move away from each others at a speed proportional to their distance (Hubble constant) and cosmology with the physics of astroparticles becomes quantitative. The particles study becomes differentiated while using other messengers than photons (neutrons, neutrinos, gamma rays and gravitational waves)
Meta-dynamics Systemicity

and the battle about quantum mechanics is particularly sharp observing the factual reality of particles as photons position and their wave duality. At the same time, Paul Dirac (1928), developed a relativistic electron theory and quantized\textsuperscript{14} a field theory, called\textit{ quantum electrodynamics} that unify relativity and quantum theories in reference with the interaction between electrons, positrons, and electromagnetic radiation. Furthermore, he shows quantum electrodynamics situations in which matter is converted to energy and energy converted to matter (the\textit{ particle of light, electricity and magnetism}). Together with such fact,\textit{ electromagnetism} is the physics of the electromagnetic field: a field which exerts a force on particles that have electric charge properties, and are\textit{ retroactively affected by the presence and motion of those particles}.

Atomic forces and reactions occurring around the planet are "rinsed out" by "the Van Allen Radiation Belt" that is a protection from solar winds (current of plasma flowing from the sun) held in place by the Earth's\textit{ magnetic field}. The solar wind pressure (magnetic storms pressure) on the magnetosphere increases or decreases depends on the Sun's activity, changing the electric currents in the ionosphere\textsuperscript{15} (ions and free electrons).

This is a short general analysis that shows very clearly the "cosmo-planetary dynamic systemicity" of those interdependent processes and forces: it is first a “primordial meta-dynamic systemicity” from which several cosmo-planetary moves participated in the emergence of Life on Earth. Within the body of those dynamic processes were (and still are) mechanisms of reactions, retroactions, circularity, reproductions, adaptations to physicochemical moves, changes and apparition of new proprieties that are all interrelated seeding systemicity dynamics in consequence of evolutionary moves. These moves were (and still are) "meta-drivers" making emerge the different bricks of reactive structures, from which, by\textit{ synergy}\textsuperscript{16}, proto-metabolisms and living system’s metabolisms were given birth, boosts, evolutionary capacities that induced to dissipative structures to be motivated as living creatures to adapt for survival to perdure.

Chemical interactions, physics of the particles, astrophysics and cosmology, matter, the vacuum, time and its arrow study, led Y. Prigogine (1977) to develop the notion of such "dissipative structures", as showing open systems operating far from a thermodynamic balance in an environment of matter, energy exchange and entropic equilibrium pressure.

"SYSTEMICITY" AT LEVELS OF COSMO-PLANETARY META-DYNAMICS

The "Systemicity" of dynamic phenomena within the Universe is a highly complex set of evolutionary phenomena within permanent interactive environments that occur between physicochemical reactions and cosmic objects dynamics: gas clouds, stars, asteroids, comets and planets like Earth. Attested by cosmic "contextual climates within galactic systems and gas clouds", their dynamic systemicity is permanently influencing the spatial milieu. The solar system, its planets, the Earth and Living creatures' behaviors for existing illustrate how each is confronted with specific dynamics. The sustaining of Life on Earth is a consequence of the set of cosmo-planetary dynamics", of which characteristics are induced by a general and universal meta-dynamic systemicity. The inventory of the

\textsuperscript{14} -\textbf{ Quantize:} restrict a variable to a specific set of values as forming into quanta (Physics)

\textsuperscript{15} -\textbf{ Ionosphere:} "the part of the Earth's atmosphere in which ionization of atmospheric gases affects the propagation of radio waves, a part close to mesosphere and thermosphere"

\textsuperscript{16} -\textbf{ Synergy:} "also, a mutually advantageous conjunction or compatibility of distinct actors or elements (as resources or efforts).
Meta-dynamics Systemicity

different sets of dynamics that shape up the "cosmic systemicity", requires to overlap quarrels on reductionism, since Life originated out of a complex and long period of heavy and unstoppable chains of atomic and physicochemical events. The Earth was molded from them, becoming the theatre of ever changing ecosystemic components under ever changing geographical structures and atmospheric climates. By remembering the entire set of long circular and retroactive phenomena occurring in the outer space, one then understands the very slow and progressive thermodynamic recycling of baryonic\textsuperscript{17} and other heavy elements within the dark matter. Gas spheres shape up into star embryos from gas and dust nodules, contract, then collapse under the pressure of gravitation within the core of frantic moves of energy (gamma, infrared, ultraviolet and X rays). The interstellar medium is filled with hydrogen gas, some helium and substances like calcium, sodium, water, ammonia, formaldehyde and other dust particles. Such mass is fed back to the interstellar medium, where it mixes with matter that has not yet formed stars.

At a galaxy level, the entire star milieu is not absorbed in by its black hole, since a part of star envelops either rebounds from the temporary formation of a spinning neutron core or misses passing through the very centre of the core and is spun off instead. This circulation of interstellar matter through stars, and the entire retroactive cycle determines the amount of heavy elements throughout cosmic clouds and shows that the constituent elements abundance is a matter of dynamic systemicity. When part of the star, in terms of interstellar matter and gas is passing through the black hole, it is firstly pragmatic to consider that such medium is simply "washed away" into the intergalactic space. Recycling going on with other elements, the "medium", together with the meta-dynamics of space systemicity, participate in the seeding of new stars around or in neighbouring galaxies.

The universe has reached to a structure, which evokes that of a 3D graph network whose nodes correspond to large gatherings of dark matter in great quantity and super clusters of galaxies, which contain several thousands of galaxies themselves containing each hundred of billion stars and orbiting objects like planets, meteorites... Here is the actual situation since the big-bang, 13,7 billion years ago. Galaxies form galactic clusters due to dynamical forces which are the gravity and the expansion of the universe as well as the intergalactic and interstellar interactions. Galaxies content of stars is largely variable as their number depends on the proportion of stars and their temporal collapse, as well as their capacity re-feeding space with gas and matter "ready" to become new star embryos.

Emerged from thermonuclear reactions in galaxies, the cosmic medium is permanently affected with differential effects that participate in "the cosmos dynamics meta-systemicity" that brings about galaxies, stars, planets and other objects to appear and disappear, giving that gases are "rinsed away" by powerful radiations that come off nuclear reactions. The historical succession of a great contextual diversity of galactic happenings and of star planetary systems birth, include that of the Sun and induced to the Earth planet to become "Life's cradle" from meta-dynamics" of which "systemicity" induced nature to flourish and the humanity species to emerge from "microscopic and light elements" – cells - as contextually constitutive of evolving species structures and behaviors.

\textsuperscript{17} - Baryon: "any of a group of subatomic particles that are subject to the strong force: the atomic nucleus, its atoms, neutrons..."
Meta-dynamics Systemicity

Geophysics and the Meta-Dynamics Systemicity,

The study of the Earth that applies to physical principles is called Geophysics. Physical phenomena and their relationships with Earth's elements, during short or extra-long term periods of time, include the Earth’s magnetic field, heat flow, the propagation of seismic (earthquake) waves, and the force of gravity. It also includes outer-space phenomena: the effects of the sun on the Earth’s magnetic field, cosmic radiation and solar wind.

The rotation of the earth in the gravity fields of the moon and sun imposes periodicities in the gravitational potential: tides, marine tides, solid earth tides (deformations of the crust) and climatic statuses changes. These include temperature, humidity, cloudiness, precipitation, wind, and pressure (physics laws of heat and motion). And have well-defined cycles and structural features (monsoons, high and low pressure, thunderstorms and tornadoes) that are the systemic drivers on Earth to make it exist.

History of the Earth Up to the Origin of Life: the systemicity of cosmos meta-dynamics

The Hadean time (4.5 to 3.8 billion years ago) is not geological. During its history, the sun was forming and was the result of gravitation until its undergoing thermonuclear fusion gave off light and heat in the outer. The planet Earth formed from gas and dust including carbon, oxygen, nitrogen, and iron ejected by ancient stars wherein the Sun's as a young stars formed. As the density of the Sun increased, the surrounding gas and dust slowly condensed, spinning around. The gravitational force of some denser areas attracts more gas and elements as the disk is orbiting the star, and some of them consolidate and grow in size and density, forming the planets of star system. The cosmos meta-dynamics systemicity makes emerge cosmic objects that have a seeding critical point, an evolving "life" and a "death" in terms of matter and energy collapse from nuclear fusion and gravitational pressure. The matter and energy cycle is re-engineering those phenomena thank to the dynamic of the global systemicity.

In the time of its youth, the Earth's global structure and climate was and is heavily influenced by cosmic forces, that of the solar system and its nuclear dynamics, together with the formation and attraction of the moon. The Earth has a history as an emergent result out of interrelated cosmic mechanics and forces that produced its "volume" with the diverse matters originated from a supernova\textsuperscript{18} burst. The Earth, as other planets, was formed from the coalescence of particles by gravity into larger objects (planetesimals) that continued to aggregate into rounding planets from matter rotation. The solar system has been like a factory space where grew rocky planets such as Mercury, Venus, Earth and Mars. "Left-over" material formed asteroids and comets. At the beginning of its history, and because of collisions between large cosmic bodies releasing a lot of heat, the Earth has probably been molten, progressively getting structured and acquiring properties for its atmosphere to develop. The bombardment of the surface by meteorites, asteroids and comets and the apparition of oceans completed its morphology from fierce pressures of forceful retroaction, fractures and compressions, some because of physical forces, magmatic moves, other chemical reactions, climate aggressions and water erosion.

\textsuperscript{18} - Supernova: "extremely bright star that has exploded due to gravitational collapse of the star's core"
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Under such dynamics systemicity, cosmic and orbiting convergent forces (ref.: celestial mechanics), and formation of an atmosphere played and plays a major role in shaping its surface. Erosion and transport of soils and rock by cosmic and terrestrial winds create distinctive landforms and patterns, together with water that is the most important sculptor of Earth’s landscape. Furthermore, in a permanent circular cycle, water is continuously evaporating from oceans, transported by winds in form of clouds, and "washing over" lands, which it carves into coastlines and river valleys. Because of its geological activity combined with temperatures, water became the "cradle" as an essential milieu for living organisms to physicochemically structure. Water and temperature brought, and are still bringing up to Earth's surfaces an anchoring soil and decreasing erosion while breaking down rock and accumulating matter in one or another place. Wind erosion, wind-driven transport of materials and volcanism also participate in ever changing the planet diverse strata and regional surfaces. Apart radioactivity that was trapped in the mineral-rich rocks that form the mantle, the motion of materials in constant convection moves from deep under the centre, producing a strong magnetic field. The force of the magnetic field said to be issued from the flow of liquid iron in the outer core (under the mantle) is shielding the planet Earth from harmful cosmic rays and the Sun’s solar winds because deviating them around.

Throughout that immense network of interrelated meta-dynamics producing interactive and emergent results, these atomic, physical and chemical events participate in re-structuring the Earth (and other planets) body, which environmental context is in a permanent evolution from sometimes breathtaking and random changes. In other words, the complex "cosmo-planetary meta-dynamic systemicity" of these phenomena changes the global landscape and contextual cosmo-planetary conditions at each single instant: changes that are few to be visually perceived at a human eye level, considering their size and long lapse of time that are to be reckoned in thousands, million and billion of years. The major example that is a fatal perspective for Life on Earth is in its programmed end when our star, the Sun will have consumed its energy; an event evaluated towards 4 to 5 Bo years ahead. On Earth, one small schedule exception in perceiving day and night light aspects under ever changing climates is however a false impression, given that the orbiting, revolving, contextual conditions are permanently differential\textsuperscript{19}. Nonetheless, one may then understand that "systemicity" is the combination and cooperation of all dynamical cosmo-planetary forces, particularly interaction-retroaction dynamics being its main formatting couple that makes things moving about with synergistic differential results.

Changes of status and phase transition

Matter exists in various forms, or phases. If the temperature and, or pressure of matter is adjusted, the matter may undergo a phase transition. Pierre Papon, (2002) describes the change of status together with the dynamic of phase changes as they confuse the boundaries with metastability. He wrote about different classes of phase transitions such as: vaporization, (the passage of the liquid to gas), fusion (the passage of the liquid or solid and its reverse that is solidification), the transition between the ferromagnetic status (the material with a permanent magnetization) and the paramagnetic status (without permanent magnetization), the transition supra conducting (the material becomes a perfect

\textsuperscript{19} - Differential: "pertaining to the difference of two or more motions"
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electric conductor, etc). These phenomena between opposite statuses usually pass by an intermediary qualification. During a phase transition, matter shifts between its three status s: solid, liquid, and gas under certain combinations of temperature and pressure, named "critical points", near which the distinction between the two phases is "almost non-existent" and fuzzy. "The status s of the matter are like the countries of a complex geography, separated by borders" he said. The passage from one status to another as named transition phase corresponds to the crossing of a border. But transition is usually fuzzy; in certain conditions, the substance can pass by a status known as metastable before changing course towards a stable status (reference to thermodynamics: entropic move). The passage of a status to another is not instantaneous and there are "undecided" statuses with particular properties, halfway between liquid and solid, such as the Earth's status transformation at the Early Achaean, or, and at the status of permafrost.

Metastability scrambles the thermodynamic borders separating the solid, liquid and gas status. Beyond of a certain range of thermodynamic parameters, the phase considered becomes unstable and necessarily passes in another status through a transitory status. The complex history of the Earth has proven successive statuses of an "evolutionary planetary body"; a history that illustrates the results of slow sequences of fuzzy changes of phase within ago-antagonistic dynamics that cosmo-planetary meta-dynamics systemicity engenders. These phenomena, perpetuating themselves throughout the Earth's and Life's actual context, show that Earth's evolutionary living conditions and survival sustainability are "governed" with the systemicity of the cosmo-planetary set of dynamical forces that retroactively sustain them far from equilibrium unless a major thermonuclear catastrophe should wipe both out.

A change of status, as observed at the passage from one status to another, is called the "threshold effect". Nature is permanently confronted with critical point examples, such as natural selection in terms of a population having adaptive responses, inhibited development…They show that the threshold effect is typically sensitive to certain characteristics of individual and group behaviors while confronted to environmental changes within specific contextual conditions. Phase transition critical point is an important phenomenon that participated in a major primordial manner to form, for example, part of atmosphere and oceans volcanic and gaseous contextual milieu at the origin of cells apparition (ref. Archaea, Cyanobacteria or blue algae).

Synergy and Emergent Results in the Field in Between Antagonistic Things

Synergistic moves, as below defined are links in processing chain development of a phenomenon. In reference to some specific works on "Synergy", published by H. Hackermann (1994), or P. Corning (2003), one can observe that the notion of pattern is intimately describing linked phenomena within a "model system of synergistic", as, for example, chemical macroscopic reactions in the form of outgoing concentric waves, spiral waves, chemical oscillations… Or the notion of physical dynamics is said describing a phenomenon of synergy: "a water vortex is the effect produced by the combined actions of several different forces like gravity, water pressure, air pressure, rotational forces as centrifugal (or centripetal) forces, even the initial status of a considered object or move. Examples are numerous, but it is important to stress the fact "synergy" illustrates sets of

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20 - Synergy: "combined action of two or more agents which produces a result stronger than their individual efforts".
Meta-dynamics Systemicity

linked phenomena, indeed combined and cooperative, given that they induce an emergent result. The orientation of the instant-t result is at next instant-t−1 usually combined with other chain of phenomena and is, at term, having combined synergistic effects, which are differentiated from retroactive effects that add dynamical moves that, from systemicity of the cycle, produce successive changes in the glocal status of the event. Synergistic is then the "arm" of systemicity meta-dynamics.

In this chapter, among many cosmo-planetary and cosmo-terrestrial dynamics implicated in the systemicity of phenomena, we will describe the essential of natural flows and cycles resulting from the "universal retroactivity", as the "meta-driver" between forces, dynamics and differential emergences. Each dynamic has a imprinting mechanism, at all physicochemical and, or biological character level that produces qualitative and qualitative effects on matter and energy. However, as being interrelated with the complex characteristics of other dynamics, the effective emerging result, at instant-t, which is usually the result of combined ago-antagonism moves, induces the environmental ambient metabolism to be permanently modified: each "ecosystem neighborhood" status evolve by some sort of a "vectorial synergy or momentum". A synergistic move, at short and, or long term in space-time, produces a temporary output effect, which confronted to the permanence of changes, becomes a possible evolutionary factor within the meta-dynamic of the cosmo-planetary and terrestrial systemicity of events.

The In-between Position of Fuzzy Value

Humans have a propensity for giving sense to an event at one end of ago-antagonist things, contraries or opposites in some sort of Manichaeism reflex. However in between the opposites is a field of intermediate fuzzy values that most often show the realism of the in-between formulation of sense given and of its value. In nature, since emerging effects are permanently oscillating, changing while confronted with the evolution of the environmental conditions, it is admitted that values are "fuzzy", usually considered as not mathematically included within the discrete numbers computation between the 0 and1 bracket. These intermediate fuzzy values or status point are however definitively derived from the moderation of an action necessary to physical, mental, physiological survival dynamics, and from feedback effects. They constitute the base of an adequate value adjustment regarding an event or the status of a momentum (instant-t) a thing goes through. The contextual evolution of things, as being permanent, the values pass through a status of transition from phase that qualifies “thresholds” (critical points), a passage to other differential values or other “given direction”, while being maintained in the field of survival intermediaries. It is to some extent the emergence of intermediate statuses as adopting a "solution of compromise". Physical, chemical, biological, animal or vegetal, societal and, or cultural, these values nourish these dynamics within permanent retro-cycling moves of systemicity, synergy and emergence differentials as sustaining a temporal momentum of survival.

While living, a creature or a social group is between "life and death": a status of survival qualification within the field of opposite extremes (in fuzzy maths, the field between 0 & 1). The intermediate field area, where the systemicity of meta-dynamics operates (e.g: a few days old instant-t) is where the homeostasis of metabolism is being sustained, playing the primordial role of survival, in terms of being a momentary critical point. The set of intermediates is made of "struggles for life behavioral moves" for an individual to survive
Meta-dynamics Systemicity

while permanently confronted with alternatives and variabilities on how to position itself by one or another successive status values produced from environment and milieu events. The incommensurable context of the "natural", its variability is, in this manner, constantly changed with endogenous and exogenous evolutionary events. Particularly influenced and, or driven with a certain number of physical and natural laws, the diversity of objects, species, individuals and societies behaviors is the source of information, matters and energy as required from survival dynamics and their epigenetic balance of sustainment.

The regulation of an ecosystem ambient metabolism, homeostasis of its components, also require a large diversity of physico-chemical reactions emerging from an the "intra-systemicity" of matter-energy-information interactions results that induce the metabolism status at instant-t to be dynamically balanced for survival.

"SYSTEMICITY": A PLANETARY META-DYNAMIC DRIVE

The "entirety" of the body of mechanisms and processes (cosmic primordial and natural phenomena), and their interwoven dynamics made Life to exist from matter and energy as well as retroactively star systems sustain. Within the solar system, natural forces and chemical streams of circular information and stimuli induced to energetic changes that provide for the renewal of vital processes substances and material, structuring and sustaining the metabolism of living organisms (vegetation, animals and micro-organisms) for their survival, at least for a certain time. It is related to the meta-intra-dynamics systemicity for creatures to coexist within ecosystems, and sustain along together from chains of energetic and biochemical nutriments resources for their survival sustenance.

The "systemicity phenomenon" is far beyond the sense given to the noun and the adjective "systemic" as referring to the notion of "systems in general": it is far more suggestive and realistic as understanding "the set of cosmo-planetary and terrestrial dynamics" as the systemicity “meta-drivers” that made life to exist and sustain. Illustrating such dynamical sense, it is simply to refer to another notion that has also a dynamic sense: "velocity": a rate of change of the position of a moving body in relation to its speed and direction of travel.

This illustration of “the notion of systemicity” is only as referring to a few dynamical moves that happened at the level of molecular biology in the early primordial biochemical “soup”. The evolution of molecules towards macromolecular compounds emerged from highly complex physical dynamics made of retro-feeding biochemical matters and energy reactions. They produced endemic capacities for enzymatic reactions and regulations from the feedback21 of emergent "differentials" as cascades of positive results. Among them, proteins, nucleic acids and enzymes were essential macromolecules to have physiological life processes that originated in a “proto-organism's metabolism” within geological and aqueous ecosystems, engendering the first creatures (unicell, then micro virus, virus and bacteria).

The Earth primordial context made them emerge because a new atmosphere, composed of oxygen, hydrogen, nitrogen…, and new terrestrial conditions induced to considerably

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21 - Feedback: "the partial reversion of the effects of a process to its source or to a preceding stage. Also the transmission of evaluative or corrective information to the original or controlling source about an action, event, or process and the information so transmitted".
Meta-dynamics Systemicity

change the environmental and biological context. Energetic resources, from numerous feedbacks, enabled more complex molecules to evolve towards cellular organisms. Successive new generations evolved as "eukaryote cells" structured with both a nuclear protection of reproduction capacities and an efficient filtering membrane capable to regulate endogenous and exogenous resources and information as perceived from environmental events together with expelling wastes. The complexity of sub-dynamics that pertain to the cosmo-planetary and terrestrial meta-dynamics conservation, in terms of survival, refer to the systemicity of dynamical physicochemical forces, energy pressure and space-time dimension. Environmental conditions in which life originated on Earth have to be remembered here, since its environmental conditions settled down along 800 million years until living organisms emerged out of physicochemical process fluxes within different geographical milieu as between -4,6 and -3,8 bo.years. A very long period of time, difficult to humans' understanding, during which primordial cells, (protocells) emerged and evolved from chemical cooperative reactions.

The Terrestrial Force of Gravity

The terrestrial force of gravity holds back any "object" being on a body surface to be projected out of its "sphere" in rotation (Isaac Newton). The attraction of the Sun prevents planets revolving around him, to fly away in space. The Moon under the influence of the terrestrial attraction remains in the Earth's orbit. From such, pressure from gravity is the main "sub-meta-driver" that sustains things to happen. The air that is basic to survival with breathing (nitrogen, N2 and oxygen, O2) is maintained on terrestrial surface by gravity and is a relatively protective shield against meteors, meteorites and dangerous radiations for living species to survive. It is charged with oxygen, as the paramount molecule to life respiration, which air-water cycle sustains diverse corpuscles and molecules to structure the nature of organisms' diversity. The atmospheric pressure, as a result of gravity, pulls the air downward, giving air molecules enough weight as to exerts a force upon the Earth's surface and everything that is on it. Winds of different forces, caused by horizontal variations in air pressure, carrying air particles and rock dusts, participate in formatting deserts from benthic sedimentation of oceans depths and by drifting coastal beach sands over inducing dunes building up. Moreover, the pressures of terrestrial tectonic moves, forcing crust surface orogeny, shape up mountains of reworked materials such as benthic sedimentary rocks. Many cycles that participate in both cosmo-planetary and terrestrial meta-dynamics sustainability, at length of a human observation, and the evolution of planetary ecosystems are corroborating the notion of dynamics systemicity; therefore, confirming the meta-drivers retroactive "systemicity".

The Cycle of Rock

Tectonic forces, heat and pressure metamorphose, breaking process of weathering and other surface processes (running waters, glaciers, waves, and winds) are transforming bedrocks down into smaller, moveable pieces. The rock cycle begins as rocks are lifted up in the magma, pushed up the planet surface and eroded. The particles, or sediment, are travelling by wind or moving water until they are deposited as a material that settles into layers. Additional sediment may bury these layers, or change the underlying sediment to metamorphic rock. Additional sediment may also compact the layers into sedimentary rocks. Rocks may sink down into the lower layers of the earth by plate tectonic processes. Buried and subducted rocks usually meld and recrystallise into igneous rocks in the
magma. Metamorphic, sedimentary, and igneous rocks are then uplifted, starting the rock cycle again.

The cycle of water and oceans

The geological history of the Earth began in a lapse of time of around 800 million years, while it changed from liquid to solid. To day, the origin of water on Earth has not been clarified; even so the world's oceans were described to have formed over the past 4.6 billion years. From a systemic point of view (retroactive differential evolution) and under the effect of the "systemicity" of cosmic and terrestrial dynamics, as contributing factors to the origin of the Earth's oceans, principles are described by: the cooling of hot gases released, as "outgassing" and, or sublimation and evaporation which are "phase transitions" of a substance into a gas, potentially bringing water to Earth. Comets, trans-Neptunian objects or water-rich asteroids (protoplanets) from the outer reaches of the asteroid belt colliding with a pre-historic Earth may have brought water to the world's oceans. Liquid or vapor, water "locked" in the Earth's rocks leaked out over a few million years. The release is photolysis, the direct process as defining the interaction of one or more photons interacting with one target molecule and radiation can break down chemical bonds separating liquid from hard mass.

The Oxygen Clue

The most primitive organisms in existence today include bacteria that live in terrestrial hot springs and in deep-ocean hot water vents born from volcanic activity. The evolutionary significance of these organisms was found from ancient sedimentary rocks that are far more abundant in iron than in modern marine sediments. The waters that deposited modern sediments are rich in dissolved oxygen, and iron in the presence of oxygen quickly turns to rust, in a process called oxidation showing that rust does not dissolve in water. In contrast, non oxidized iron dissolves, moving into the oceans in waters flowing down rivers. Traces of oxygen could cause this iron to precipitate out of the water and fall to the ocean bottom, without turning it to rust. The abundance of iron in primordial sedimentary rocks therefore suggests that there was very little free oxygen on the early earth, either in the atmosphere or dissolved in the oceans.

While it is said that "more than one of these factors contributed to forming the vast oceans", it is also likely to postulate that the first living creatures capable to increase the oxygen rate in the atmosphere were algae and some bacteria structuring stromatolites rocks. Algae chloroplasts with chlorophyll use sunlight to assimilate carbon dioxide and produce glucides, while releasing from oxygen. A chemical component of water that, over more than a billion years, was produced in such volume that it progressively changed the atmosphere composition, so as to be breathable but also capable to activate the amount of water vapor that induces to different paleoclimatic changes, precipitation into rains, runoff waters and recycling with evaporation.

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22 - Stromatolite: "a fossil rock with a structure worked out by a community of microscopic organizations, primarily various types of bacteria and algae" (photosynthesis).

23 - Atmosphere: actual components are nitrogen (78 percent) and oxygen (21 percent). In the remaining 1 percent are argon (0.9 percent), carbon dioxide (0.03 percent), variable water vapor, and trace amounts of hydrogen, ozone, methane, carbon monoxide, helium, neon, krypton, and xenon.
Meta-dynamics Systemicity

The Cycle of Air and Atmosphere

At the time of its completion as a solid body, the Earth's atmosphere was of water vapor, nitrogen (N$_2$), methane, some hydrogen and small amounts of other gases: some carbon dioxide (CO$_2$), very little breathable oxygen (O$_2$)...

J. H. J. Poole, University of Dublin (~1947) postulated that the escape of hydrogen from the earth led to its oxidizing atmosphere. The hydrogen of methane (CH$_4$) and ammonia (NH$_3$) might slowly have escaped ("rinsed out" by the Van Allen belts moves$^{24}$), leaving nitrogen, carbon dioxide, water and free oxygen. At the Earth's surface, warmth was of a temperature over 49° C (120°F) as a result from volcanic and tectonic activity still going on with less intensity and frequency. The air composition is primarily described in terms of temperature, pressure, wind speed, wind direction, precipitation, and humidity. Cool air sinks and creates high-pressure air flows. It is drawn back to low pressure near the equator, creating a cycle of air winds. Winds converge there and create a zone of dynamic weather, recycling vapour, air and sunlight heat energy up to the troposphere, then moves toward the North and South poles and gradually cool to sink down again. Waters of the oceans have the same kind of cycle, while heated from solar energy. The winds recycle energy, dissipating more of it in the air process than energy dissipated by the combined ocean currents, tides, continental drift and mantle convection. However, these dynamic cycles, that are permanently interrelated, show how much they participate in the differential of retroactive effects on nature. The long-term fluctuations of the average weather – the climate – together with the fluctuations of ocean waters – currents - make earth historicity an important part of life's dynamic systemicity and evolution of the planet life to sustain.

The Cycle of Climates

Sun's radiation has long-term climatic seasonal effects (temperature and precipitation) on earth atmospheres and surfaces, while it is rotating and orbiting around it. The Earth's rotation deflects winds circulation: tropical and polar winds and two intermediate belts go east in each hemisphere. The atmospheric structure and composition, the heat currents transported by oceans, the latitude and altitude of plateau, mountains and lakes induce to different climate levels. The average ambient temperature grades from tropical above 20°, subtropical, temperate and cold between 10°-20°, polar below 10° C. Precipitations in each hemisphere are differentiated by their frequency (all seasons summer, winter) and climatic zones (equator, tropics, arid and dry, temperate, polar). For example the zones called: the "selva" for equatorial rain-forest with hot tropical rain much of the year; the "savanna", with warm, strong seasonality; and the "tundra", with cold, strong seasonality. Climate effects on life are significant in all bio-physicochemical processes. Animals, humans and vegetation show their diversities according to the different areas of continents. Humans nowadays alter the Earth's climatic zones, consequently Life's creatures, with pollutants and chemicals on the soils and in waters, and carbon dioxide into the atmosphere.

These processes are all constitutive of the "cosmo-planetary and terrestrial meta-dynamics systemicity" and here, their interrelations are generally described.

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24 - Relativistic electrons: "populations of relativistic electrons (relation between energy and velocity) and ions in space form or change in response to changes in solar activity and the solar wind".
Meta-dynamics Systemicity

Cosmic, Planetary and Terrestrial Body of Dynamics: cycles retroactivity influence

Largely produced by the Moon's tidal forces, combined with cosmos meta-dynamics (laws of physics e.g.: gravitation), the Earth's spins slowly reduced at one revolution in its axis making days to become longer, a retroactivity that is having an influence over natural terrestrial cycles. In the early of Earth, if abundant volcanic activities emitted off much heat, they diminished, inducing the formation of the first rocks from a crust cooling down together with a great change in the atmosphere composition and its weathering effects. The oldest rocks (cratons) are known to have been in the mechanical coupling between the outermost layer of the mantle and the crust (asthenosphere and lithosphere), as one of the forces that drive plate tectonic and is dated 3.8 billion years old.

Known as the Archaean\(^{25}\), this period of time would be 200 million years younger than life's origin also dated at 3.8 billion years, so was raised the problem of its origin at high temperatures. As the Earth's rocky crust slowly formed continental plates (small embryonic surfaces called "cratons" were found) the stable part of continents was "excreted" from the Earth's mantle systemicity (cycle of magma-rocks). The cycle consists in internal moves from the Earth's core up to the surface of the continents and bottom of oceans, in other words the convecting system of the mantle, away from hot mantle zones toward cooler ones. This process known as continental drift, together with the subduction of plates into the mantle is a systemic drift move (Plate tectonics) that produces earthquakes and volcanic eruptions and major changes of continents geography over hundred millions years like the surge of mountain chains and the apparition or disappearance of oceans, seas and crust fractures. Together with the "cycle of rocks", the "cycle of water" participates in the "cycle of air" and the "cycle of climate".

At the same time, as having interrelated effects, they participate in the adaptation of large varieties of physical mechanisms and chemical molecules, later to living creatures to adapt for surviving to environmental conditions. These sets of terrestrial dynamics participate in "Life's Systemicity" where retroactivity is paramount to the survival of living systems a synergistic emergent temporary fact. An evolving climate during billion of years prepared conditions propitious to the apparition and development of Life: the terrestrial aqueous context combined to temperatures of relative heat of different cycles. The set of cycles, as having differential emergent results, at each instant and at different macro-meso-micro levels, permanently change the interrelated dynamical contexts, which demonstrates the "historicity" character of "systemicity" as the meta-driver of evolution.

The Planet Earth Named "Gaia" as a Living System

The "Systemicity outputs" are illustrated with some of J.E.Lovelock's (1979) developments over the planet Earth existence as being a living system he called "Gaia". Lovelock's theoretical approach is based on:

- The thermodynamics second principle: matter tends towards an increasing entropy, or disorder, in terms of physicochemical balance, thus its degradation and extinction,

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\(^{25}\) Archaean: "pertaining to the earliest known forms of rocks; of or belonging to the earlier of the two divisions of Precambrian time". "The Precambrian is divided into pre-Archean time (from the formation of the earth to 3.8 billion years ago), the Archean Eon (3.8 billion to 2.5 billion years ago), and the Proterozoe Eon (2.5 billion to 570 million years ago)."
Meta-dynamics Systemicity

- The "survival principle" opposes itself against disorder since Life constantly renews its molecules from biological retroactivity and adaptation (also see later the molecules of emotion),
- The "cycle principle" is the result of retroactive processes like the cycle of water in an ecosystem.

The process of sending status information back for comparison with previous status information is called feedback, and the whole process of the input, output, error or difference signal, and feedback is called a closed loop; however differences in the status qualification induce the loop to get open the next step. The variations of status qualifications in gains or losses oscillate around a critical point depending upon the type of system and its sensibility to entropy. The environmental conditions on Earth, at the time Life gradually came out of the limbo, were strongly radioactive and the atmosphere, with very little oxygen and no ozone. It was above all exposed to UV radiations. The pressure of Earth mass and accumulated energy of its radioactive components heated its interior to the point gases and vapour expelled from it, participating to the formation of air and oceans. Among these gases was enough hydrogen for life's elements - organic components – to form and survive: hydrogen is present in the universe and is essential to life's components (carbon, nitrogen, oxygen, phosphorus, iron, zinc and calcium). Hydrogen is also the fuel of sun that provides, together with water, the flux of energy essential to the physiology of organisms. The presence of free oxygen induces to the development of oxydo-reduction in environments: oxide components reject oxygen – rust become iron - and "hydrogen +" induces to balance acids and alkaline. If these condition have enough potential, then environmental milieu are prepared for the physicochemical development of the components that will develop Life. Further more, the temperature of the Earth surface was constant, actually in favor of Life to develop.

The abundance of organic chemicals together with side waters and solar energy provoked reactions in favour of the production of Life's components (acids, reactors…) that were progressively interacting and reproducing while they were tossed around within bubbles in shallow and tidal waters. We arrive at the point of this description, where bacteria and viruses appear as single cells, which mean that DNA had completed their assembly capacities (nucleotides, genes, chromosomes) and that survival metabolic functions were at the origin of cells to exist: the filtering membrane as integrating physicochemical information, energy, expelling wastes, protecting their integrity and capacity to manage a reproduction cycle, coding proteins, producing molecules. At the time probably emerged the predator-prey dynamics from a specific chemical survival consciousness capable to memorize defenses information learnt from the milieu. In ecosystems' metabolism, the ecological dynamics such as cell's circulation and survival communication with the neighborhood are first found in the field of oscillations, within which predator-prey populations occupy a resource, or several as well as managing a balanced sociality, Without going further into James Lovelock work, the back office of this description is again understandable in terms of "systemicity" and dynamics that were and still are participating to the dynamic of moves, particularly the function of feedback positive and ago-antagonistic biochemical reactions. Furthermore, it comprises a large set of functions: autocatalytic chemical reactions, reaction diffusion, morphogenesis, instability dynamics and pattern surge, activator-inhibitor drivers, self-replication...
Meta-dynamics Systemicity

Here again, at the Earth's cosmo-planetary dynamic level, the set of cycles having differential emergent results, at each instant, at different macro-meso-micro levels, but permanently changing the interrelated dynamical contexts, demonstrates the "historicity" character of "systemicity", meta-driver of evolution. The history of Earth, a true odyssey, is consubstantial to that of the cosmos, given that the galaxies and stars (matter and energy cycle), has an evolving history to perdure in a limited long term: such is the Sun.

THE APPARITION OF LIFE

The hydrologic and winds cycles, described as a transdisciplinary approach of contributing dynamics, are in the circulation and conservation of Earth's water that is in a frequent status of change (surface water evaporates, cloud water precipitates, and rainfall infiltrates the ground...). It is most probable that the whole volumes of water contained on land, in oceans and the atmosphere was progressively attained to in a dynamic balance with the increasing volume of oxygen in the atmosphere. The formation of the Earth crust within a changing atmosphere, changing land and ocean environments was changing temperatures and still is. The hydrologic cycle cannot be considered as a closed system since it is reactive with the planet cosmic behaviors, itself under the influence of the presently described "cosmo-planetary meta-dynamics systemicity" and other terrestrial dynamics. Participating in, the sun dynamics, gravitation and orbiting position are some of the components of the set of "the general meta-dynamics Systemicity ".

As for winds, one has to consider other dynamics that influence the systemicity of moves: air masses and circulation fronts. Cold fronts and warm fronts and different type of advection are collectively forming global and local climates according to the status of water or air, temperature, moisture and vortex advection conditions. If global winds result from solar heating of the Earth and the differential heating between the equator and the poles, the rotation of the planet (Coriolis effect) and the magnetic fields are major influences on the atmospheric circulation of air and clouds masses. Analogues are the characteristics of the parameters that participate in the formation of oceans currents.

The complexity of "cosmo-planetary, terrestrial and life's meta-dynamics systemicity" where interrelated cosmo-planetary and terrestrial forces interact is well specified. The interconnectedness of each of every physicochemical and biological cycle within the 3 dimensions of geographical ecosystems produces differential opportunities for matter, energy and organisms to behave, adapting themselves to their temporal conditions and evolve as facing the reactivity of environments. The "cycle of rocks", the "cycle of water", the cycle of winds and temperature"

The Cycle of Oceans Salinity

The oceans get most of their salt from rivers, volcanic gases and hydrothermal vents on the ocean floor. As water is cycling between the oceans, the atmosphere, and the land over hundreds of millions of years, the salts from rivers remained in the oceans, which explain why seawater is saltier than river water. Ancient salt deposits indicate ocean salinity as
Meta-dynamics Systemicity

having remained relatively constant along 1.5 billion years. Salts are removed from seawater when they bond chemically to clay sediments as they sink to the sea floor in a process called reverse weathering. They are also removed to the profit of marine plants and animals to form body parts and by evaporation forming minerals or blown from waves into the air, leaving a salty aerosol in the air or a salty film on nearby land. The cycle of salinity goes on when uplifted ancient rocky seafloors are weathered releasing ancient sea salts that rivers carry back to the sea. The density of salt participate in the current of the seawaters across the world, together with their temperature, so seeding the systemicity of those dynamics. The dynamic is retroactive and participate in Life's to exist: cells, animals, plants, humans, all must retro-regulate their "osmosis" to a certain amount of salts in their tissues in order to provide chemical exchanges within the living organisms for hydration.

Cycle of Carbon

The cycle of carbon usage by which energy flows through the Earth's ecosystem is basic to cells evolution when photosynthesizing algae used carbon dioxide (CO2) found in the atmosphere or dissolved in water. Incorporated in plant tissue as carbohydrates, fats, and protein, the rest is perspired to the atmosphere or water (respiration cycle). Since herbivores eat vegetation, their metabolism uses, rearranges, and degrades the carbon compounds: CO₂ as an aerobic respiration is partially stored in animal tissues and is cycled on to carnivores feeding on herbivores. Wastes and decomposition matters are broken down and their CO₂ is being used again by plants. Continuously circulating in the Earth’s ecosystems, it is a carbon dioxide gas in the atmosphere as used by plants in the process of photosynthesis. Animal respiration and photosynthesis balance to keep the amount of atmospheric carbon relatively stable given that a certain amount contributes to underground by-products (petrol...). However, nowadays, the humans with extra carbon dioxide production from industries and fuel usages perturb climates cycle, ecosystems and milieu metabolism.

In conclusion of this chapter, the systemicity of terrestrial dynamics, the different levels of their synergy, retroactivity and convergence of emergent results, at instant-t, explains that, from feedback effect, perturbation, so minimal would they be, induce to amplified moves within the different cycles as illustrated by the "butterfly effect" metaphor. It acknowledges the actual critical situation of the global warming cascade of threats.

The Dynamics of Systemicity and Apparition of Life

The “primordial systemicity”, within which the body of dynamics were (and still are) mechanisms of reactions, retroactions, circularity, recursive production and reproduction, adaptations to physicochemical moves, changes and apparition of new proprieties, can be considered as evolution seeds (emerging results). The moves were (and still are) “drivers” making emerge the diverse bricks of reactive structures, from which, by synergy, proto-metabolisms and living system’s metabolism were boosted up, and induced to the building up of dissipative structures that became (and still are) adaptive individuals and societies, from cell species to actual humans.

It was early in the Archaean that life first appeared on Earth around -3,8 billion years ago. Oldest bacteria fossils date to roughly 3,55 billion years ago, and consist of early

26 - Synergy: "a mutually advantageous conjunction or compatibility of distinct actors or elements (as resources or efforts).
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autotrophic bacteria. They probably grew both deep under oceans near volcanic gushes and along ancient seacoasts enduring harsh sunlight as well as episodic wetting and semi-drying from tidal cycles. Environmental conditions like subaquatic volcano emergences with significative temperature and gas effects induced some living most primitive creatures (Archaebacteria) to develop, finding energy and metabolic nutriments from chemical reactions within a rather hot context of water and matter milieu. They constitute a taxon of the livings characterized by cells without core and distinguished from the eubacteria\(^{27}\) by certain biochemical characters. Later, eukaryotes cells (2,5 bo,years) have a nucleus enclosing the replication mechanism of DNA and a flexible cellular membrane.

Bacterial Populations: structure and metabolism for survival in a contextual milieu

In order to describe a "systemic process", the specifications and configuration of the system's components must be put into a form compatible to analysis, design, and evaluation of its structure and behaviors, giving that systemic dynamics manage the individual metabolism and morphology of creatures. For example, a unicell has a neural-like chemical function with proper centres (memory chemical basins) for survival information treatment or a jellyfish that is the simplest organisms having neuronal functions in form of a one neuron brain to retroactively manage its survival.

Bacteria are mostly of three groups: Aerobic bacteria with survival response to gaseous oxygen for growth and existence. Anaerobic bacteria are living in deep underwater sediments. Facultative anaerobes grow in the presence of oxygen, and then can grow without it. Bacteria are also classified by the mode to obtain energy: Heterotroph bacteria extract energy from breaking down organic compounds of the environment - as in decaying material, fermentation or respiration. Autotroph bacteria, fix carbon dioxide as a food source. When fuelled by light energy, they are photoautotrophic, or by oxidation of nitrogen, sulfur, or other elements, they are chemoautotrophic. Photoautotroph bacteria include the cyanobacteria, as photosynthetic organisms using water and sulphur bacteria that use hydrogen sulphide instead of water. Bacteria cells and viruses built interactive and interdependent communities, which, along extended period of time of evolution and natural selection, structured the first plankton creatures. Phytoplankton (algae as autotrophic\(^{28}\)) and zooplankton (protoza as eukaryotic\(^{29}\)), usually single-celled, are micro-organisms that became the primordial apparition of food chains constitutive of all extinct or actual species. In that respect, the major "survival dynamic principle" is a consequence of the "predator-prey process at quest of energy", a chemical process that emerged while the RNA structured. Many of them learned how to extract oxygen from water or how to produce it.

In perspective of a molecular phylogenesis approach of primordial biological matters as corresponding to genes producing ancestral proteins, Joseph Thornton, (2006) developed and tested primordial proteins as big molecules intervening in most functions of organisms. Primordial proteins that had not participated to organisms' metabolism for billions or hundred million years are coded from gene sequences and discovered together with mixed software models of phylogenesis methods that are finding evolutionary moves, were heterogeneous. Both molecules as individual and social entities participate in the

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27. Eubacteria: type of spherical or rod-shaped bacteria.
28. Autotrophic: light (photosynthesis) or of chemical links (chimiosynthesis).
29. Eukaryotic: having cell organelles and nuclei with chromosomes.
Meta-dynamics Systemicity

formation of macromolecules and organisms given that the survival phenomenon supported by reproduction requires the retroactive differential result of energy consumption. Joseph Thornton developed his researches with methods issued from molecular phylogeny that uses software capable to compare actual genes in order to rebuild an evolutionary history of molecules together with paleomolecular biology. He studied how genes develop new functions by introducing ancestral genes into diverse environments (hot, cold, acids...) and observed the way evolution is adapting to these milieu conditions. However, rebuilding ancestral milieu is of a large probabilistic and would be partial (fragmentary).

Mechanisms and Components of “Life's Systemicity”

Physicochemical biologic world, in terms of Life cannot be described to Universal Laws as Evelyn Fox Keller, MIT, wrote in Nature 2007: "Biological phenomena are permanently contingent upon evolution". Planet Earth, the "Gaia" ecosystem, is also subject to evolution dynamics, in a context of homeostasis within a framework of evolutionary long term structural changes that are contingent to terrestrial cycles and the biological ecosystem evolution. These general phenomena and events cannot be theorized but may be considered as relying upon provisional "rules or generalizations" and the development of probabilistic computerized models data. Submitted to cosmo-planetary and terrestrial physicochemical mechanisms in terms of universal laws (for how long?) and geophysical cycles, the biological organisms and their physiological cycles, fluxes and behaviors are ever changing and adapting. Their capabilities usually fit differently according to environmental world areas conditions, climates and seasons, given that orbiting and magnetism are implicated together with solar system winds and the gravity effects. "Living beings behaviors" are reducible to the dynamic of physicochemical reactions, as well as the "biops" fluxes (see chapter 5: "environmental-physosomatopsychism", its acronym "e-psop"). Cells all possess membrane chemical reactors that behave according to the world of opiates, as molecular emotion participating in managing survival; this is a major discovery made by Dr. Candace Pert, on a biomedical research on emotions opiate receptors, endorphin and peptide that explain how feelings, emotions are connected through our mind with the body. In other terms, how the body-mind functions are set in a single psychosomatic network of information and interrelated molecules that participate in the intra-systemicity of survival dynamics controlling health and physiological statuses. In biology, hypothesis have but "an intrinsic value of given explanations" and will never become more than a tentative to develop "theoretical principles", since "Life survival replication data" permanently emerge from ever changing phenomena on an orbiting planet submitted to the cosmo-planetary and terrestrial meta-dynamics changing effects. Some mechanisms, like the Darwin biological evolution work describing principle, method and mean of species adaptation to environment, are sometimes considered as a theory. However, since a theory implies large data evidence that is a world of "variables", Life's moves are not invariable under the same condition.

Moreover, primordial life appeared within specific combinations of those dynamics effects where water and temperature encountered specific physicochemical statuses and values that have much different oscillations today. As a matter of fact, in terms of evolution, one is now able to describe the massive quantity of information contained within nucleotides emergent results considering their permanent interactions, in an ago-antagonistic manner,
with ago-antagonistic events of the milieu. It is observed that biological values oscillate at a constant evolution rhythm from which one is only capable to bring about one or another fragment of Life's complexity. Furthermore, biological phenomena cannot be reduced to specific molecules: DNA segments are "associated" to genes in ways that also evolve while confronted with an ever changing body milieu metabolism and contextual events that weigh upon organisms behavior, retroactively affecting genes expression while renewing proteins and enzymes sets.

**Feedback: Differential Retroactivity Results**

A "feedback" is the process that enables "loop control" moves participating in the management of systems' regulations processes. In a closed-loop system, a feedback dynamic device has the property permitting to an output (or some other controlled variable of the system) to be compared with an input to the system (or an input to some other internally situated component or subsystem of the system) so that the appropriate control action may be formed as some function of the output and input balance. Most cycles of the cosmo-planetary and terrestrial dynamical materials and energies are retroactively sustained and then evolving, at least within the influence of galaxies gravity on the very long term of their "immense spatial life". More generally, feedback is said to happen in a system when a closed sequence of cause-and-effect relationships exists between the system's survival variables. In parallel, an "open-loop control" function has a distinctive control action since it is independent of the output. (J. Distefano, 1967). The "Sun" and its planets, a star system, has an evaluated life length of another 5 billion years ending into a supernova blow out, which matter, chemicals and energy will seed again the interstellar space and neighboring star-systems, in a cascade of retroactive moves. The seeding is historically and retroactively sustained but confronted with the thermodynamic entropy that end with a thermonuclear matter bust feeding the apparition of new star-systems (ref. to supernovae life). On Earth, organisms are confronted with entropy and degradation (breaking down) that feed back new elements for survival of the food and reproduction chains.

The most important feature a feedback imparts to a living system's integrity and behaviors is in its comparison function that continuously detects differences existing between inputs and outputs effects from endogenous and exogenous stimuli that provide appropriate signals or information necessary to manage input-output differences. One may call such retroactive move the "survival capacity driver" submitted to the collective meta-dynamic systemicity (meta-driver) of the cosmo-planetary and terrestrial environments. In a biological movement, such as reaching an object or reacting to endogenous and exogenous events require some chemical outfit reactions that interpret and decide what to reach, positioning a "body", what behavior to have for security or getting a resource within reach. At different levels of action, variable signals are piloted out the sensitivity of chemical substances, cell's receptor filtering and organ functions (e.g., light chemical vision as conversion of information, like eyes one) and from their reactivity to "biops" drives. (e.g.: unicell "brain"30 for survival have chemical memory capacities for survival management, bar receptors regulating blood pressure by inhibition drives…) Biological processes might not have an accurate ability to reproduce faithfully an input, then the reducing effect of non-linearity and distortion usually drives to some oscillation or instability. This is why

30 - **Unicell's brain**: biochemical processing information close to more elaborate neural function as the one neurone Aplysia.
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the circularity of moves is primordial for the maintenance of dynamics, in Life's infinite complexity, for chemical exchanges are generating feedback drives (or biological interactive emergent "biops") results that affect the survival streams steadiness (dynamical balance) of the object, while confronted to entropy.

Biology and Modelling: a Description of Primordial and Fractional Process Interactions

The "Science of the Living" has made immense progresses in the understanding of its mechanisms, particularly since the genome was globally and chemically deciphered. From such base and from computerized data, many biological tests in laboratories enable scientists to reproduce and describe some of the Darwin natural selection and evolution mechanisms. The "paleomolecular biology" is a method applicable to genes sequencing, which is the DNA synthesis applied to computerizing some of its models. By sequencing models of gene fragments and test their capabilities to behave, it was obtained simulations of the reproduction of proteins that went silent for billions and, or hundred million years. However these tests cannot be but fractional since it will never be possible to biologically restructure the whole RNA, DNA of past species since the building up of genes should individually take into account the impact of environmental conditions of the moment, in other words, to reproduce the contextual "dynamical systemicity" of the surroundings they happened to emerge from, live in, reproducing and adaptively evolve. "Primordial organic functions" have surged along a very slow evolution of positive physicochemical reactions confronted with the entropic world (during ~ a billion years). The interaction between biological processes produced dynamic results that emerged from their being confronted with the permanency of the thermodynamic "work" within specific ecosystems and fluxes. Prior to the apparition of gene segments coding proteins, organic functions have induced to physicochemical combinations from which emerged the "RNA reproduction capacities" of unicell. Life was in limbo until unicell developed (bacteria, archaeabacteria…) and "cells are the atoms of the living world". A single cell is often a complete organism in itself, such as a bacterium or yeast. However, virus types of organism raise the question of the "egg or hen paradox" used as a metaphor, so anyone here may propose questions: "when appeared the predator-prey chain mechanism"? Is the answer within the sole physicochemical milieu that developed this essential function to life? Would energetic results and effects be the clue? Biochemists, biophysicians and molecular biologists certainly provide important information on the subject, even though anyone has his own arguments to answer to such questions as confronted to biological phenomena. A food web is made of "interconnected dynamic food chains by which energy and materials circulate": the emergence of primordial chemical reaction in the form of a biomolecule predating for energy is a dynamic result. The first move that happens is at the level of energetic electrons that absorb and reject energy while transferred from one atom to another during oxydo-reduction reactions. A dynamic that makes biomolecules to exist as they are made of atoms linked with energy, therefore participating in the systemicity of the living.

31 - "Biops": the acronym for a bio-physicochemical event.
32 - Polymerase chain reaction (PCR): a molecular biology technique for enzymatically replicating DNA without using a living organism.
33 - Virus: "microorganism without a cell wall, able to reproduce only by inserting itself into a host cell and hijacking the reproduction mechanism for its own ends".
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Percolation, Interactivity, Amplification of Disturbance, and Phase Transition

Life has happened through dynamic percolation of physicochemical phenomena. Percolation is a process of communication in an extended environment where quite a number of "sites" are locally likely to relay information (physical, biological or of a fluid property (J. M. Hamersley, 1957). They communicate with links whose effectiveness is most of the time random. According to whether the proportion of active connections is, or not, higher than that of a threshold value, the information to long distance may be transmitted since overpassing critical points. Percolation relies upon the critical phenomenon that is constitutive of a phase transition\textsuperscript{34}: below the threshold, information remains confined in the spot where it originated; beyond the threshold, "percolated" information is then found far from its starting point by passing over a critical point. The particular situation of transitions from phase is one out of many physical or chemical move phenomena occurring to number of cosmic, planetary and biological mechanisms. The appearances of highly sensitive behavioral conditions issued from phase transition are also observed in social life organizations. Disturbances permanently modify living creatures' behaviors and their metabolism while they interact with environmental events and stimuli. Alike the butterfly effect, a small fact can induce to important and perverse effect in attitudes and physiological statuses amplitude. Societies of creatures are meta-organizations functioning at the verge of a lethal equilibrium that is a compromise between contradictory constraints not predictable and controllable, but maintaining a timely and temporal survival. However, from feedback effects, the situation might be severely sensed as depending on their weight on people expectations.

"Survival Principles", major to intra-biodynamics systemicity

At the Asilomar ISSS 48\textsuperscript{th} conference (2004) I, J.-J. Blanc, described "Living systems' survival" as a circular and regulating set of dynamic moves permanently fed along with bio-physicochemical ("biops") matters, energy and information from feedback results emerging from necessary interactions with endo-external milieu. The retroactivity of phenomena, which I call "Meta-dynamics Systemicity" is fundamental to survival and suggested to me another and complementary approach in form of a psycho-physiological new paradigm. As central to Life's dynamics systemicity, the nervous circular system is a network of interactions and retroactions with stimuli in environmental areas of life: ecosystems, brains, internal milieu, bodies\textsuperscript{a}. This phenomenon I named: the "environmental-psycho-somatopsychic" cycle, (a neologism and its abbreviation: "e-psop") because survival is a matter of circularities. The whole body of interdependent biophysicochemical mechanisms, processes and streams, interwoven in a 3D milieu, within interdependent networks shows that systemic abilities and performances for any individual creature to survive come from dynamical forces. Because of permanent changes in behavioral statuses, one understands then "survival principle" as the result of many forces and moves as constitutive and common processes like for example: feeding, reproducing, self-defending... Evolution dynamics, from genetic inheritance to apprenticeship, adaptiveness and education participate in managing the different survival dynamics.

\textsuperscript{34} - \textit{Transition phase}: "a movement, development, or evolution from one form, stage, or style to another."
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LIFE'S INTRA-DYNAMICS AND THEIR SYSTEMICITY

Life's requires in itself an important inventory and argumentation about dynamics as capable to become realistically understood and described: their interactions, in terms of being capable to sustain an endogenous dynamical equilibrium in a milieu that is based on retroaction differential and emergent results and adaptive proprieties, has happen to much complicating along evolutionary trends. This work is then limited to the description of a few aspects of intra-dynamics that introduce our next works since they are at length part of the meta-dynamics systemicity theories presentations.

Systemicity “Ins and Outs”

Electrical impulses, biochemical energies and physiological "biops" matter flows, sustaining relevant biological behaviors and actions processing, contribute to the "dynamic stability" of every living system's survival networks. As fitted in with the permanency of changes and the maintenance of the circular moves fluidity, the system's viability sustaining survival is emergent from the percolation\textsuperscript{35} of moves surging along the flow of "biops" element exchanges, spot to spot, area per area. This vision and approach of survival moves is pertaining to all living system's physiological, body and societal levels, from cells to supra-national societies. Observing and describing them, requires an homogenous approach of the footbridges and links that build up the connectivity of systems' networks for survival needs and dynamics. To get things able at such level of transdisciplinarity, one must adopt the use of analogies and metaphors, since straight principles or rules are not convenient or disproportionate for a pragmatic understanding of dynamical subjects (the Maxwell origin theory, the use of J.G. Miller's “operator's metaphors"...)

Reproduction: the Systemicity of a Paramount Emergent Survival Dynamic

The ultimate determinant destiny of survival is evidently the living systems to have "an unconscious and conscious sustainable and adaptable capacity for reproduction" in a limited space-time lapse. All living systems (individual as well as communities) are exposed to "a pattern of numerous events, each individual or in aggregate having a certain lethal probability at any moment, causing a total probability of death or survival. Climatic and other terrestrial changes in ecosystems modify the frequency of various potentially fatal events that weigh upon chance and physiological specificities of living systems as to become mature. Progressive "endo-systemic" changes, inasmuch as growth, reproduction, development, and senescence are intrinsic characteristics in the organism as capable of modifying the effects of the living creatures upon various environmental factors and moves". The words "survival dynamics" and the notion of "reproduction" are emergent results of "Systemicity drivers" and the most important notion of self-maintenance of a living system. Not only surviving is "to overpass a possibly lethal event, leaving survivors as better adapted", but it is also expressing the permanent strive of the physiological structure of a creature while managing the diverse dynamics that maintain its identity and integrity (its "self") for staying alive. It requires all systems to have a specific individual degree of consciousness, memory and reproduction features in order to fully participate in the circular seeding of the energetic survival food chains in ecosystems. Henceforth, since "survival" creates reproductive sociosystems (family, group, local society, national society, human society,)

\textsuperscript{35} - \textbf{Percolation:} " to spread gradually,
then living systems have to be open-loops with internal and external behavioral processes that are never linear because of the permanency of changes. in ecosystems (niche, local neighborhood…) where cohabit with, several interwoven networks of predator-prey food chains. Many creatures species, adapted to sets of niches (as composing a 3D space-time ecosystem’s region), are also categorized as highly complex living systems, such as a reef. They, at such level, require the use of pragmatic metaphors that help decipher their complexity.

The study of dynamic systems reveals frequent periodic oscillations and it is probable that, in certain cases, these oscillations are produced by a set of fuzzy phenomena, implying cascades of interactions within metabolic processes. Where the climate and local physicochemical statuses (e.g. volcanism) weigh heavily upon the environmental status, the systems' metabolism has to cope with an endemic acute and entropic pressure. If a metabolic cycle, for instance, proceeds with the interface of an aqueous medium and of a membrane or a charged wall, the phenomena of electric interaction, which are exerted between the fixed loads of the membrane and the ions present in the medium, are of nonlinear nature and can create dynamic periodical and, or fuzzy changes. Many periodic phenomena were modelled, showing in labs what effect a local property could generate within a system's metabolism homeostasis from a single periodic "processing value". The induced new property might strongly disturb the metabolism at an instant-t or for longer: a phenomenon that is analogue to the "butterfly effect" notion.

These moves are interrelated within the body of dynamical processes that participate in the "Life's Systemicity", and sustain survival motives as well as circular and retroactive processes do flow.

The Neural Brain and systemicity

With the apparition of single cells, then neurons structuring brain like survival outfits of species, a biochemical treatment centre of circular information evolved and became complex neural centres made of 3D neurons networks among which, with the "limbic area" and its main components, the amygdala (central to emotions) and the hypothalamus36, manage survival dynamics (nervous and endocrine vital nets) confronted to endogenous and exogenous stimuli. Among different aspects of "Systemicity", living systems' survival moves are: self-consciousness, thinking (a biochemical information treatment) and other metabolic functions that are emergent from inferred37 representations, sensations and emotional fields of autonomy. They induce to understanding the building up of images (and, or sense given to things) as ending into the permanent systemic mechanisms necessary as to sustain survival behaviors. These bio-psychophysiological moves ("biops") are individual aptitudes, which, from motivations of the moment, participate in the satisfaction of survival needs. They require the use of memory functions in connection with the information treatment centre so as to fit with environmental conditions.

Located in the primary brain areas, the cortical levels (specially the cerebellum and the limbic ones are common functions to many species) as memory basins (or their

36. **Hypothalamus**: “the hypothalamus contains a control center for functions of the nervous system, and has important links with the endocrine system”.

37. **Inference**: by extension, an inferred representation, and/or an emotion, is the result of interpreting sensorial information that once treated is being stored in memories.
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equivalence). There, information and emotions stimuli are inferred and treated unconsciously and, or consciously, inducing to a "primary thinking" and a silent speech, which, in physiological terms, participates in sustaining life's metabolic processes.

Psycho-Somatopsychic Reflexivity

At the Asilomar ISSS 48th conference (2004), the author, introducing the notion of "systemicity" and the theory, first described “survival”. Survival is a circular and regulating set of dynamic moves permanently fed along with a psychophysiological body of streaming biochemical matters and information within the emergence of feedback results that are "retroactive positive differentials" when referred to as survival dynamics. Moves that are fed from survival interactions and retroactions result as emerging from endogenous and, or exogenous effects of milieu changes. The body of these retroactive phenomena is fundamental to living system's survival, then suggesting another and complementary approach in the form of a new paradigm as central to Life’s dynamics. At a first level, survival is systemic, made of circular phenomena as the emerging products of interactions within ecosystems and body structures milieu. They yield to the notion of the “environmental-psycho-somatopsychism”, a neologism and its abbreviation: "e-psop", which the author postulates as being fundamental to Life's sustainability because of its circularity effect within a living body physiology. Thus, a major example of the above "systemicity" resides in the perfect "reversibility and circularity" of psychosomatic and somatopsychic phenomena while interacting with the milieu and the environments (named "e-psop"). Links (or bonds) and footbridges processes fit in with sensory information networks. They convey environmental endogenous and exogenous dynamical stimuli, from events filtered throughout the "specific individualistic function and networks" (personality of the system) to a central bio-physico-chemical treatment center and, from it, outwards influencing the environmental milieu. These phenomena have suggested "the notion of systemicity" as central to understanding living system's survival.

The interconnectedness, interdependency and continuity of “behaviors and reactions for survival” (reproduction) require millions of "biops" interactions from which emerge resulting moves. They percolate in "cascades" throughout the external and internal networks of the "body-milieu-brain-environments-body", as "epsop" circular moves that are part of Systemicity dynamics". Behavioural contexts that require of the system those capabilities and qualifications that ensure, or not, the circularity of survival dynamics fluxes. Endogenous and exogenous metabolic processing abilities induce to performing viable interactive moves from treating environmental stimuli signalling internal and external event changes. The dynamic streams of molecules, organizing the connectivity of numerous interdependent mechanisms and processes networks, ensure such continuity participating in the perpetuation of life’s sustainability and adaptability, i.e. a metabolism for survival.

The environmental psycho-somatopsychic ("e-psop") processing is to become a "generalized notion as of being central to circular flow procedures" that participate in managing any level of fundamental values as being major survival principles.

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38 - "e-psop": here a 3D graph metaphor for highly connected networks that represents the interdependent interconnected physiological, sensory and regulatory sets of metabolic processes.

39 - Procedure: "a particular way of accomplishing something or of acting and a series of steps followed in a regular definite order (surgical or biological procedure,)."
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Consciousness and awareness, emotions and thinking, intelligence, representation and abilities to behave, are universal survival functions, whatever living system is concerned. Considered as, at first, the "protogenes" of Life, they are "the foundation of a "biops processing substratum" that build up the different survival values according to the "meta-driving effect of systemicity" as required for diversity sustaining retrosurvival.

The Systemic "Required Variety": a “Required Systemicity”

Life's indispensable diversity, said "required variety" is significant of moves circularity, exchanges and the diversity of their qualifications, which, issued from feedback and reflexive actions of ago-antagonist loops, produce emergent and sustaining results. They echo with "Life's systemicity" background and, by inference, shape up the structuring of living systems' behaviors at every (t) instant. Their motivations for survival, in accordance with the circular throughputs of keeping on living, mostly emerge from facing the predator-prey chain game and answering to all environmental events they are concerned with from searching for energetic resources in terms of nutriments. Because of survival significant behaviors, such stimuli induce to a constant adaptation of adequate strategies towards the global entity of their mind-body-external environment and internal milieu metabolism. Indispensable bio-psycho-physiological ("biops") fitness provides for maintenance of their integrity and survival dynamics. Vital are the diversity of their homeostatic\(^{40}\) and functional autonomy and self-organization, as well as their maintaining an "external homeostasis" with other species individuals and the neighborhood wildlife context and, or human fauna, and is particularly significant of the "required systemicity" for living creatures to appear and survive.

Evolution

In order to approach the evolutionary Universe and the systemicity of objects and living system's behaviors, let's recall the whole of cosmic phenomena as not unscathed from evolutionary historicity. The very slow transformations of the universe (astromathematic extrapolations) emerge out of a great number of dynamic phenomena, gathering in three categories:

- those that are physical and chemical constraints towards cosmic objects in terms of physical laws: thermonuclear energy, gravitation, cosmic radiation energy…
- those that are “beneficial” within the time of a dynamic balance of forces effects, which, being endemic, maintain the cosmic object far from a lethal thermodynamic balance (balance of statuses) during a physicochemical phase transition at a certain lapse of space-time,
- those that are retroactive effects generating changes of status on the surface and, or within the object, while maintaining a momentary integrity of its components.

Therefore, the analysis of the historicity of an evolving cosmos, it is judicious to assume that the systemic theory of the planet Earth, named “Gaia, a living system” by James Lovelock, shows that its evolution is subject to analogous convergent effects relative to:

\(^{40}\) Homeostatic: "a relatively stable status of equilibrium or a tendency toward such a status between the different but interdependent elements or groups of elements of an organism, population, or group
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- those dynamic phenomena that are constraints towards its evolution (cosmic forces, entropy, energies...)
- those endemic phenomena that balance the surface qualities of the planet Earth's and of its internal milieu (environmental cosmic and terrestrial forces influence)
- those biological endemic retroactive phenomena that are beneficial with the perpetuation of life.

Mechanics shows the fundamentally relative character of balance and the movement, which well define evolution as a synergistic differential result emerging from the systemicity of a set of meta-dynamics: mass, force, displacement over a distance, time, velocity, acceleration, interaction, retroaction, phase transfer over a critical point... Thus, one can postulate without concern, nor anthropomorphism, that the “systemicity” such as before defined is exactly a meta-dynamic set of universal forces and processes that are interdependent and doubtless conditioning the differentiation of surface and milieu statuses evolution and retroactive effects mostly interrelated at endo - exo - endogenous differentiated levels of any cosmic objects metabolism. However, the planet Earth actual status of a living system, as per James Lovelock's Gaia description, is the result of both the "cosmo-planetary meta-dynamics" and "Life's dynamics" systemicity that together influences the whole Earth system evolution, affecting both the physical and chemical environments and living organisms evolution.

Survival Metabolism and Evolution from Systemicity

Biological mechanisms and chemical processes moved from energetic resources are being systemic. The retroactive positively differential physicochemical results were first to structure organelles metabolism, which, on to next evolving steps, participated in the building up of the living organisms' metabolism as single cells. Larger molecular and enzymatic "interaction and interrelated results" emerged within geospheres and aquaspheres and induced to the apparition of protocells (without nuclei but with functional compartments, or organelles). Among them, some bacteria, from photosynthesizing functions require only water as giving out an electron and producing molecular oxygen. Some organelles became “organs of new organisms” called eukaryote cells that integrates several different organelles as functional entities participating in the metabolism of the cell and its reproduction. There, the ARN induced to form the DNA nuclei, with ATP and nuclear acid...)

Evolution and Dynamics systemicity

The biological evolution and development of physicochemical particles (atoms, electrons, molecules...) is governed by the body of those dynamics that structure the “Life’s global and complex systemicity”. Among these dynamics and beyond physical and chemical forces and energies, are some major impulses and fluxes that participate in, such as: synergy, emergence, evolution (from emergent natural information selection...as contextual perception, silent thinking and argumentations...). They illustrate the evolution of “biops” processes, facing permanent changes, named "irreversible" since reactions happens far from a status of equilibrium, also named "dynamic balance" (survival) and which opposes a dissipative force against the natural thermodynamic loss of energy named "entropy". Life is defined as “the status of an organism especially fit and characterized by
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its capacity for its metabolism to keep up its sustainability from growth, reaction to stimuli, and reproduction” and, as mentioned above, with a dissipative structure tailored for survival maintenance. However, the first specific organism as capable to exist has a vesicle but no nucleus: the unicell or single cell that is a prokaryote. It slowly emerged from a set of processes from arrays of physicochemical retroactive matters forging mechanisms and processes that have together, as the body of primordial dynamic phenomena, gave access to reproduction from sustaining behaviors. A context of thermodynamic forces, within the natural composition of the two successive atmospheres around the planet Earth, progressively induced to the building up of biological proto-structures that, from assembling, became capable to protect themselves from the ever-changing exogenous events. At such epoch emerged the proto-membrane that became a filtering wall (reactors) for a cell to survive.

Living Systems: an Ever Changing Move of Physiological Conditions and Behaviors

Living creatures, as well an individual as a societal entity, are "functioning wholes" according to the body of survival dynamics phenomena. They are organisms that cannot be understood by means of sole physical and chemical principles. Actually, described physiological networks, metabolic, neuronal, endocrine, humoral and immune processes are understood as globally being biological parts of "a whole set of processing network streams" occurring both inside and outside the "system's skin" and should be called "regulation networks" (and not systems). Because of their interdependence and specific localizations, the enormous information volume treated at instant-t must be participating in such wholeness, even though it is of much larger volume than that necessary to the synthesis of the elements implied in the functioning of percolating moves throughout the biological networks. Complex, biological networks answer general laws for living organisms survival often postulated as being common to other "processes and their mechanisms", however then inaccurately called "systems". Because of organisms "milieu" and environments permanent changes, interactions between the components of a living system induce to evolution of its proprieties: they usually emerge with differential qualifications often showing no exterior events to have intervened. The system becomes irreversibly different. Therefore, a living system evolves from one level to another level of organization: thus, and for example, a cellular level would succeed to a molecular one, showing that the "global systemicity drivers" have dynamically intervened as described above.

PROVISIONAL CONCLUSION

“Systemicity and its dynamics as “Life’s drivers” are consubstantial to the cosmic origin of planet Earth's drivers, suggesting that glocal phenomena are also tuned with the “ticktock” of the biological clock that sustains life against entropy. Maxwell predicted with metaphors that they are producing the "compost" for theories to emerge, suggesting to me the development of the "Theory of general dynamics systemicity ". It was postulated that a further development of these new theories will require its transdisciplinary structure to be composed of many other chapters for complementing previous papers and future issues. The description of "A General meta-dynamics systemicity" and "The Life's intrabiodynamics Systemicity" are, step after step, the result of developing a very large work in volume and time.
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The "Theory of Life's intra-biodynamics Systemicity" is here an "abridged description of some of the life's mechanisms and phenomena historicity", and shows the presence of those sets of dynamics that have, level after level of the physicochemical cosmic evolution, structured up the emergence of "Life's meta-drivers", their development and the forces and sub-dynamics that compose Life's apparition.

Furthermore, this work strongly suggests that any species and its societal organization be scrutinized, better understood and described within the principle of "meta-systemicity drivers" sustaining survival behaviors as emerging results. A large approach on the surroundings and actual dynamics variations confronted to entropy status would enlarge the quality of the expertise. Permanently emerging from the world of physicochemical and biological processes studies, vital survival behaviors should result from a sustainable, adaptable and endurable Life's context and human new strategies. The survival of the livings is in danger because mankind produces aggravating degradations implicating the global society intelligence, actual human cultures, socioeconomic attitudes and human systems as fruits of thinking, creativity, warlike competition and obsolete political attitudes.

I am now observing that my intimate conviction there could not be a "general system(s) theory", assuming Ludwig von Bertalanffy biologist's theory was superseded, as I expressed it as from 2000. It is here confirmed since I have inventoried and linked most of the physicochemical events issued from "cosmo-planetary and terrestrial meta-dynamics systemicity" mechanisms, drivers and processes. They bring up the strong evidence of "Systemicity, as a general universal move" within the reality of differential result retroaction.

Since the apparition of Life, every individual living organism and communities, from unicell to the actual living creatures (humans included) is submitted to a universal contextual "meta-dynamic systemicity" that shows cosmic objects and living beings having a diversity of specific and common survival dynamics while submitted to the evolutionary effect of the cosmo-planetary and terrestrial forces. Microgravity at the subatomic level is probably behind a general systemicity.

In conclusion, it is here also postulated that "Systemicity" is the mechanism of retroactivity, a feedback result linked to synergistic and emergence. "The general systemicity" of cosmic objects is part of the entire physical universe metabolism, its dynamics equilibrium since it includes gravitational effects and retrofeeding capacities. The theory of "A primordial general systemicity" will be the 5th stage of my works, and hope not being the last.

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Systems Theories: Le Moigne J.-L., Miller J., Rapoport A., von Bertalanffy,

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ABSTRACT
The new tourist modality generates a tendency toward the values and the importance of the natural environment. It is also consistent with the nature, social and community values, and allows a positive relationship between residents and tourists. This new tourism tendency is regulated through a new development model that is being proposed at a world level: the Sustainable Development Model.

The paper exposes the design process of a Municipal Integration Model for Sustainable Tourist Development, where the possibilities of intervening elements' interrelations are studied to achieve a union among municipalities in order to promote and revitalize the tourist cycle of the region with the use of Systems Paradigm.

The Orient Zone in the State of Mexico is proposed as the study target, due to its resources. However, it is intended that the pattern could be applied in diverse regions of the country that fulfil the necessary elements for its implementation.

Keywords: Systems Paradigm, tourism, sustainable development, municipal integration.

INTRODUCTION
Tourism is a preponderantly economic activity; however, it has evolved with men through its relationships with society. Along the conformation of the tourist activity, it is possible to identify that through the technological advance, tourism adopts a development possibility for the countries; this way the technology used during the Second World War through the deployment of the airplanes for daily use, tourism acquires the way to open new markets. This opening allows the diverse visitors to move to new destinations and as a consequence, to develop the tourist activity.

In Mexico, the development of the tourism is increased with the Port of Acapulco, which begins the development of the massive tourism and the approach of the traditional tourist pattern that mainly consists of vital elements as the sun and the beach. This outline of traditional development remained in the preference of the tourists during several years, however, societies evolve, and new relationships as well as new recreation forms are developed for human beings. The traditionalist approach was no longer enough and is no
longer fulfilling the visitors’ expectations. In order to face this necessity, a new vision of practicing tourism has born an alternate approach to the one that has been already mentioned that is denominated “Alternative tourism”.

This new tourist model represented a new development path for the phenomenon, inside which, important world organizations proposed new development forms toward this tendency. Nevertheless, the environmental problem and the social problems that reigned in the world cooperated to the development of this new approach, in which, tourism and the local or municipal administration is preponderant. There are diverse definitions for the alternative tourism, however, a constant aspect presented in all of them, is that the mentioned tourist modality is considerate to outline a closer interrelation with nature, and is preoccupied about the conservation of the natural and social resources of the area in which the tourist activity is held. In order to conceptualize this activity, the following definition it is emitted: The trips that aim to carry out recreational activities in direct contact with nature and the cultural expressions that enwrap them with an attitude and commitment of knowing, respecting, enjoying and participating in the conservation of the natural and cultural resources (SECTUR, 2004).

This new tourist modality generates a tendency toward the values and the importance of the natural environment, it is also a tourism that is consistent with the natural, social and community values, and allows a positive relationship between residents and tourists (Wearing & Neil, 1999 in Newsome, Moore & Dowling, 2002). It is also important to mention that this new tourist tendency is regulated through a new development model that is being proposed at world level; the Sustainable Development Model that is also applied to tourism.

The new development model that we know as Sustainable Development is presented as an alternative to the models that have propitiated the degradation of the environment, starting from the search of creative answers to correct the flaws and to avoid new problems. This concept was transported to the economic activity in the decade of the seventy’s and was presented as the reference point of the new positions for economic and social development at the end of the twentieth century (Leff, 1990). A series of political, economic and social events occurred all together in 1972 such events determined the contriving of the development strategies in every field. The world crisis began and had energy as one of the more outstanding and unchaining factors. The first report of the Rome Club was published. The First Conference on Human Environment took place at Stockholm, and in Paris an agreement promoted by the UNESCO about Cultural and Natural World Patrimony was signed. In Europe the Economic European Community started the first program of action on the environment (Ceballos-Lascuráin, 1998).

All these meetings were focused on the pattern of economic development model and the diverse problems that capitalism causes as a production way, reason why the sustainable development model emerges as the possible solution to the problem that generates the evolution and capitalist development. In the field of the tourism; meetings, congresses and
forums were held to debate different aspects of this activity. It is this way that in 1991 the International Association of Scientific Experts of the Tourism (AIEST) described sustainable tourism as the one that maintains a balance among the social, economic and ecological interests (Jimenez, 1998). The tourism should integrate the economic and recreational activities to the objective of the natural and cultural values conservation.

Two years later, in 1993 the World Tourism Organization (OMT) defined the concept of sustainable tourism: The sustainable tourist development responds to the necessities of the current tourists and the receptive regions, protecting and enlarging the opportunities for the future (UN, 1993). Sustainable tourism is presented as rector of all the resources so that the economic, social and aesthetic necessities can be satisfied maintaining the cultural integrity of the essential ecological processes as well as the biological diversity and the systems, in defense of the life.

In 1995 at Lanzarote, the First World Conference for the Sustainable Tourism takes place, favored by different institutions as the UN and the OMT. The main achievement of the conference was the Promulgation of the Letter for the Sustainable Tourism whose principles set the bases for a World Tourist Strategy based on the sustainable development (OMT, 1995).

From these principles we can extract a definition of Sustainable Tourist Development: The tourist development will be based on sustainability approaches, that is to say, it must be long term bearable ecologically, economically viable and equal from an ethical and social perspective for the local communities. The sustainable development is a guided process that contemplates a global administration of the resources with the purpose of assuring its durability, allowing the preservation of our natural and cultural resource, including the protected areas. Being the tourism a potent development instrument, it can and should actively participate in the strategy of sustainable development. To be able to achieve a sustainable development or tourist sustainability, strategies should be carried out, considered these as the means by which those long-term objectives are achieved. They are also potential actions that require decisions on behalf of the institutions and corresponding organisms for its realization. In this sense, this paper as a part of a research presents the design of a Model for the tourist development, under the strategy of municipal integration.

**Context**

The global tendency, considers the tourist phenomenon as a road of economic development, because it is an economic activity that propitiates the economic spill, which generates, the possibility to elevate the life quality level in a country, joined to the increment of foreign currencies that help stabilize its global economy (Thomas & Long, 2001). Nevertheless, this traditional productive activity is a development that depredates
the environment. An environment friendly model of development, has been world level proposed for several decades now, such model is known as Sustainable Development Model, this sustainability is also transported to the tourist activity, this is how the strategies for the environmental care and preservation are set within a juridical frame mark so that they can be respected, this bears a balanced development, preserving the resources and generating a sustainable perspective for the destinations (Buttler, 1991).

One of the activities of great relevance for Mexico is tourism. After industry, it represents the second place in the generation of employments and income. In Mexico, just like in many other parts of the world, tourism has been deviated because of its operation and commercialization, losing sight of its true mission that corresponds to offer the experience of knowing new culture forms and natural life. On the other hand, a tourist complex based on the sale of a comforts infrastructure has been settled down and displaced the local communities, causing adverse environmental and social impacts. Associated to the environmental and socio-cultural dismantle, such a conception of tourism doesn't usually irradiate economic benefits to the local population, except for its participation in poorly remunerated employments and in the sale of some low quality manufactured products. A typical example is the Acapulco Diamond Tourist Complex.

Nowadays, Mexican society in some sectors reflects about the lack of programs and projects of specialized tourism in our country, such reflections come from some experiences of alternative tourism that nations like Spain, Costa Rica, Belize, Guatemala and Rwanda, among others, have taken advantage of, reaching important income of foreign currencies and developing sustainability characteristics. The National Plan of development 2001-2006, sets tourism among its national priorities, and recognizes it as a very important productive activity; therefore, it channels the impulse, through the National Program of Tourism (SECTUR, 2001). This Program is structured in such a way that manages 4 rector axles, where tourist municipal development is inserted.

In Mexico "Agenda 21" program has also been created, as a program that proposes strategies and actions in the short, medium and long term, with the purpose of strengthening the dynamics of the tourist regions; to include the local communities in the generated economic activities and to assure the preservation of the natural and cultural resources of the tourist destinations of Mexico.

On the document Politics and National Strategy for the Sustainable Tourist Development, presented in year 2000 for Mexican Tourism, Agenda 21 is the continuation of the reference frame mark proposed in a combined way by the participant agents of the sector and the Tourism Ministry Office of Mexico (SECTUR). The above long term strategic planning is incorporated as a tool for the design and conduction of local programs to strengthen tourism in states and municipalities; however, in the short term, it maintains a practical focus in order to establish the actions required for their application in the municipalities and tourist destinations (SECTUR, 2000).

The municipality has a protagonist role in the installation of the program and in the
Systems Science Approach to the Design of a Municipal Integration Model

application of the Agenda 21 for Mexican Tourism. In this context, the municipality works as a strategic promoter to assist the local environmental challenges, also as the great leader of the change and connection processes among the groups that interact in the local processes of economic, social and cultural development.

Justification

The tourist Municipalities can perform the role of leaders in the local and regional tourist area, which would allow a population's sector to obtain benefit from the same economic spill that the tourist phenomenon causes. The proposal aims to the competitiveness and tourist development, since, as long as a place has competitiveness in the tourist market, its development is possible.

The competitiveness of the tourist destinations depends on the capacity of its industry to innovate and to permanently improve the quality of its product (Porter, 1991), this indicates the need to generate new outlines that allow regions of the country to be positioned in the tourist market, the improvement of a destination's competitiveness should also be considered from a local point of view, before developing national policies.

Considering the current scenarios of tourism in the country, the generation of development outlines where the elements and tourist resources are integrated for a harmonic development is indispensable. It is considerate that the local development is the pillar of the national development, and this is emphasized in the necessity of promoting a structure that determines the way toward the tourist competitiveness. Therefore, it is intended to design a Systemic Model of Municipal Tourist Integration that strategically promotes and develops the outlines for the growth of the tourist activity in the orient zone of State of Mexico.

METHODOLOGY

The system’s paradigm was used to perform the research. This approach is very appropriate for the tourism research since we deal with dynamic structures or systems that are not composed of homogeneous elements but of heterogeneous elements and its identity is determined by its position or by the function that they carry out in the structure or total system; therefore, in this kind of research we require concepts and instruments appropriate to their own nature.

The system’s paradigm assumes the possibility to reach a dialectical synthesis between quantitative and qualitative methods, considering them not opposed but complementary (Martínez, 1997). Stands for the necessity to not be limited to explain and to understand the phenomenon, but rather it also introduces changes guided to improve the system. It centers its objective in the application of the knowledge to transform reality (Tejeida, 2002).
Systems Science Approach to the Design of a Municipal Integration Model

Inside the systems paradigm there are several models and methodologies, such is the case of the Soft Systems Methodology (SSM) that is the one used in this study. The soft systems methodology can be described in a summarized way, as a flexible process of seven analysis stages that use the concept of human activity system as a mean of getting so much to investigate the situation as performing actions to improve it (Checkland & Scholes, 1990).

DEVELOPMENT

The opportunity for the municipalities to become able to negotiate and to plan their own development, started in 1982 when the article 115 of the Federal Constitution of Mexico, was modified, allowing the Municipalities the ability to promote, to negotiate and to plan their own development, however in the tourist area there are no projects that impel jointly a group of municipalities territorially near, for the development of their tourist capacities. Considering this problematic and with SSM the model was developed.

Description of the Non Structured Problem

In this stage, the situation of the problem is experienced in first place by the researcher. That is to say, the researcher's experience on the nature of the situation is necessary as much as possible.

Based on the documental information analyzed in this research, and on the experiences about the development conditions in Tourist Municipalities, we can establish a first vision on the elements that intervene for the municipal tourist development model conformation (see figure 1). This Tourist System of Municipal Integration is inside a supra-system including the general aspects that influence its formation and development.
One of the systems that directly relate is the federal policies one, since in essence such policies are those that would allow this development model to be promoted in a region, determining the importance of the policies in the economic, ecological, tourist areas and social development. Another system that is intimately related is the one of the municipal policies that just like the federal ones, are necessary for the implementation of strategies for the development of the tourist activity.

The companies of the tourist sector are elementary in this proposal, since the proper system working depends on their service's efficiency and quality. In addition, the most important sector is the local community, given its approval, through the acceptance and the integration of the local communities to the tourist activity as a part of the economic sector; we will be able to speak of a holistic and integral development.

Finally, the environment where this model is developed implies the necessity to consider the economic development model, and the global tourist sustainability, reason way the diverse world dependences or international organisms that carry out deep studies of tourist development framed in sustainability were indispensable for the development of this research.
Interpretations

In connection with the previously exposed, it is possible to observe that the main model of planning for the internationally accepted development of tourist municipalities is the Sustainable Development that international organisms such as the WTO and the UNESCO propose as the most suitable road for the municipal tourist development.

The Sustainable Development Model is the main planning mechanism that implies the development of tourist municipalities, however this is the atmosphere in which this system develops, the mainly involved characters are the municipalities, in their autonomy of implementing a program of municipal tourist development.

The Tourist Municipalities, through their policies and municipal regulations and specifically in their development plans, can impel programs of tourist development, which are concerted in the National Plan of Development 2001 - 2006 and in the Agenda 21 for the Mexican Tourism 2001 - 2006.

The participation of the private sector, that is to say, the local companies, is indispensable to strengthen the tourist activity and has a direct relationship for this development model. The local community as well represents an important sector.

With the purpose of obtaining useful information for the methodological development, an instrument was designed; such instrument helped gather the necessary information about the possibility of generating an outline of tourist development in municipalities through the correlation of the systems, and about the positive and negative aspects potentially generated if an outline of municipal tourist development is proposed.

Many outlines of tourist development have been designed in Mexico, and some have worked satisfactorily. For instance The Mayan Route, Heart of Mexico, and Route of Cortés; however, the reality of recreation options is surpassed. The tourist offer planned in tourist developments, and they get more demand, on the other hand, there are small local regions that can cover the local population's necessities and neighbouring communities, these can as well satisfy the recreation necessities of the country in general.

There are many local projects, but they are not linked, and they are not part of a group of tourist offer, such situation displaces them competitively in the tourist market. Most of the population has low resources, therefore local destinations, strategically located, are proposed and they can be the solution to capture these markets and to cover those necessities.

Situation of the Non Expressed Problem

For this stage, a detailed description was developed, an enriched vision where the logical and cultural focuses of the situation are both spilled, inside which the problem happens.

The purpose is to obtain the possible relevant systems. In order to accomplish this, the rescued symptoms or anomalies of the non-structured problematic situation are grouped,
Systems Science Approach to the Design of a Municipal Integration Model

with the objective of relating them to a general problem that is supposed to be the cause of all those anomalies in the system.

Root Definition of the Relevant Systems

A relevant system is the one that the researcher names as a candidate to generate discernment in further stages of the study. For each relevant system, a definition root is formulated, and a conceptual model is built.

For this logical analysis, the memory technique CATWOE is proposed as a confirmation list to make sure that the important characteristics of the root definitions are included.

C = Client. The clients are the users, those that obtain benefit with the system, in our case they are specifically the following:
1. Tourists or Tourist Market
2. Private Sector, Local Companies
3. Hosting Community
4. Local Population

A = Agents or actors, who will be in charge of the information entrances transformation in to exits:
1. Municipal Authorities
2. Public Officials, DDE
3. Federal Government, SECTUR
4. Hosting Community, Local Companies

T = Transformation. It is the entrance conversion in to exit, that is to say, the exit will be the Municipal Integration Model for the Tourist Development (see figure 2.).

---

**Fig. 2. Transformation**
Systems Science Approach to the Design of a Municipal Integration Model

$W =$ It is the relevant world of the Weltanschaung that is to say the vision of those involved. The visions coincide with the interpretations of the first part and we can summarize them in table 1:

**Table 1. Synthesis of the vision of those involved**

<table>
<thead>
<tr>
<th>Involved actors</th>
<th>Positive vision</th>
<th>Negative vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal Authorities</td>
<td>Promote the tourist image of the Municipalities.</td>
<td>The lack of a planning outline for tourist development.</td>
</tr>
<tr>
<td></td>
<td>Inter-municipal work whose benefit is regional.</td>
<td>The lack of specialized personnel.</td>
</tr>
<tr>
<td></td>
<td>Display information about the municipalities as tourist sites.</td>
<td>A necessary investment for infrastructure and the creation of new local medium and small companies.</td>
</tr>
<tr>
<td></td>
<td>To generate revenues on Tourism's account.</td>
<td>Lack of trust to integrate a group of promoted municipalities and to be tourist developed.</td>
</tr>
<tr>
<td>Hosting Community and Local</td>
<td>Greater development opportunities.</td>
<td>The rejection to tourists.</td>
</tr>
<tr>
<td>Private Investment</td>
<td>Creation and organization of</td>
<td>Degradation of the natural and cultural environment.</td>
</tr>
</tbody>
</table>
### Systems Science Approach to the Design of a Municipal Integration Model

<table>
<thead>
<tr>
<th></th>
<th>New Companies</th>
<th>Contamination of the natural and cultural places.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benefit of the economic spill because of tourism.</td>
<td>Maximum occupation only in seasons (High, Low, or weekend).</td>
</tr>
<tr>
<td></td>
<td>Generation of new employment sources.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contact with other cultures.</td>
<td></td>
</tr>
</tbody>
</table>

|          | To increase areas of tourist development at national level. | Application of economic resources for the support of development programs. |
| Federal government | To offer and to diversify the regional tourist demand. | Support for the personnel training of Tourist Municipalities. |
| (Programs of Development, Local Tourist Market). | To promote the tourist development in non high-priority areas. | Lack of control through the State Offices of Tourism. |

**O** = The owner, the decision makers whom in this case are the municipal authorities, with support of the Federal Government, through their dependences, such as SECTUR, and the State Program of Tourist Development.

**E** = Environment. The environment remains defined in the first stage of the methodology:

- The State Administration of Tourism and their tourist programs.
- The Municipal Governments and their Development Plans.
Systems Science Approach to the Design of a Municipal Integration Model

- The Areas of Tourist Development.
- The Experiences of Tourist Development in other countries
- The strategies of Tourist Development and the resources.

A root definition expresses the nuclear purpose of an activity system with a defined purpose. Such nuclear purpose is always expressed as a transformation process in which some entity, the "entrance", changes, or transforms into a new form of the same entity, the "exit".

**Conceptual Model**

The Soft Systems Methodology suggests the elaboration of a conceptual diagram of the studied system, where the interrelations of the different elements of the system and its exchange of information with the environment are shown. The following systems were found in this study:

A Human Administrative System that is integrated by a subsystem of tourist planning, another subsystem called Administration of Economic Development and an Inter-municipal Tourist Committee.

A Technical System, where the training thematic is approached for the development of the municipal tourist integration model.

Finally the Strategic Administration System, that has the primordial function of the coordination and interrelation of the previously exposed systems and the monitoring and feedback with the environment; in such a way that the correct operation propitiates the economic spill and the regional and local development as a consequence of the tourist activity in the region.

The environment where the proposal is developed, and that directly and indirectly impacts the whole system.

The Conceptual Model of the Municipal Tourist Integration System is presented in figure 3.
Comparison of the real world, with the consideration of systems of the real world

The AHP (Analytic Hierarchy Process) was used in order to contrast the conceptual model with reality. This method consists on formalizing the intuitive understanding of complex problems by means of a hierarchical model formulation. The AHP tries to untangle a problem and then to unite all the solutions of the sub problems in a conclusion (Saaty, 1998).

The purpose of using this method was to allow to structure a multi-criterion situation in a visual form, by means of a hierarchical model construction constituted by three levels: the first one represented by the regional tourist development relevant system; the second level, by the administrative human system, the technical system, the strategic management system and the environment; the third level constituted by the relevant systems’ dimensions along with their corresponding alternatives. This way the goals or objectives as well as the criterion and alternatives were set. In order to perform the analysis, a team of experts was integrated by two groups. The first one integrated by
Systems Science Approach to the Design of a Municipal Integration Model

academics specialized in tourist research and in local and municipal development issues and the second group integrated by municipal authorities.

The process allowed, organizing the information regarding the model, to decompose it and to mathematically analyze it by parts; to visualize the effects of changes in the levels and to synthesize.

Definition of the feasible changes and actions to improve the situation

Tourism is an eminently location related activity, that is based in the existence of natural and cultural tourist resources in a certain geographical space (Callizo, 1991). This conceptualization is the one that should be considered to detonate the local tourist activity.

The participation of the municipal city councils in the tourist activity in Mexico is incipient. Therefore, the tourist activity doesn't have a great development in the local economies, since it doesn't represent an economic activity as such. However the new tendencies, and according to the manifested plans of tourist development, in the official documents (SECTUR, 2001), the intention is to integrate the tourist activity to the municipalities, and as a consequence to diversify the tourist offer.

To achieve a tourism based development in the local economies, is necessary to recognize the importance of the tourist activity and this requires the participation of the different involved sectors, that is to say that they all work together for the achievement of the goals. The federal government through its dependences, should strengthen and provide the communities as well as the municipal city councils with tools, and should also dedicate public financing for the local tourism. This process is necessary, so that the local tourist destinations can be a tourist alternative, however the installation of the model would be a gradual process, from the exchange of information among its environment, until the synergy generation among the systems.

The federal, local and state government should join efforts to dedicate resources, and to motivate the creation and development of new local tourist projects. The local government is responsible for its geographical demarcation; reason why in union with other local governments can gather elements to detonate the tourism in its towns.

Training is a primordial element in order to provide an efficient service. In tourism, it is essential because the resulting good is a service. Given this complexity, its valuation is qualitative; consequently, an efficient service is indispensable in the tourist destinations. To achieve it, training is required and along with it, facilitators that guide the services’ providers to the efficiency. These actions are regularly carried out by the Tourism Ministry office of México, either at federal or state level; it trains the services providers’ personnel, by means of the intervention and solicitude of the municipalities. These actions are supplemented with the established regulations in the National Plan of Tourism of México (2001-2006) in the sections regarding to competitive companies.
CONCLUSIONS

The role of the municipalities in the tourist activity is essential, since these through the aldermanship should carry the leadership of the tourist development, by means of a plan elaborated with proposals of each one of the actors involved in the municipal tourism, as well as representatives of other productive sectors, with the desire of integrating them to the economic development through tourism. However, participation and the federal government's support is necessary to impel the local tourism in countries in development like Mexico where the public financing for the rural development is still promoter of economic processes.

The Economic Development Directions in the municipal city councils, should consider the joint work, to define new plans of tourist development and to integrate them to their municipal development plan. These actions will allow a better outline of the local tourism. Regularly in the municipalities, the Economic Development Direction is the one in charge of the economic sector, therefore, it is necessary that it involves the tourism as a productive sector, and further on that it generates plans that motivate the growth of the activity in its town.

The model supposes an interaction among the actors, reason why the experts consider the opinion of the local communities as well as their necessities, relevant for the destinations and tourist products planning.

Integrating the municipalities to a tourist development implies a planning process and development execution. The process is complex by virtue of requiring to make coincide political will, participation of the private and social sectors, methodological outline of planning, pertinent execution and application of technical knowledge, everything focused in an endogenous development model that truly benefits the communities. This is a core problem in the reality of the tourist municipalities in the orient zone of State of Mexico, because independent to other factors, the local tourism at the present time, doesn't involve an interrelation among all the participant actors.

The tourist activity should be held according to the current situation of economic globalization (integration and international competition), where the productive systems should be modernized to avoid being left off the market, but the balance between conservation and profitability should be sought. This vision is compatible with the sustainability outline that has been managed in the last years.

REFERENCES


Systems Science Approach to the Design of a Municipal Integration Model


Further reading


A VIABLE SYSTEMS MODEL APPROACH TO ENTERPRISE RESOURCES PLANNING SYSTEMS

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ABSTRACT
The Viable System Model (VSM) is recursive and helps explaining the general production management model of the ERP system. The recursion level explains the development starting from warehouse management to Material Requirement Planning (MRP), to Manufactory Requirement Planning (MRPII), to Enterprise Resources Planning (ERP), and to Supply Chain Management (SCM).

In each recursion level, the emergent concepts helps explaining the discovery of the two categories of demand: independent demand and dependent demand, the feedback concept helps explaining the closed cycles in ERP, the local, future and total environment concept helps explaining the interactions between the market and the Production System and the Law of requisite variety helps to manage complexity.

Keywords: Viable Systems Model (VSM), Enterprise Resources Planning (ERP), Recursion Level.

INTRODUCTION
Management of manufacturing systems is the science, art and profession to lead such systems from a state of development to a different and better state of development. The processes of improving manufacturing systems are well known. One of these fundamental processes is the planning and control of Materials, Energy and Information (MEI) flow.

Research, planning and control of the MEI flux is taught since the early days of Taylor’s industrial management, but it was until 1975, when Joseph Orlicky published his seminal book “Materials Requirements Planning”, when learning on this new techniques began.

For any enterprise, the focus of financial management is the capital flow. In ERP systems, production and financial management are the core function, while other modules, either offer services or provide them, Financial management reflects an enterprise's business performance and managerial efficiency (Zhuqiang Zhu, 2006).

According to the cybernetic model of any Viable System Model, there are five systems interactively involved in any organization that is capable of maintaining its identity and transcend independently of other organizations within a shared environment (Beer,1989). If an organization survives in a particular sort of environment, it is viable.
VSM approach to ERP systems

All manufacturing systems are embedded in a continuously changing world economy system and environment. Success in global and local markets with social satisfaction requires constant unrelenting efforts to develop more viable manufacturing systems, aware of quality and sustainability.

SYSTEMS CONCEPTS

The following brief systems concepts descriptions, help understand the development of enterprise resources planning (ERP) systems (Laszlo, 2003, Crete Glossary. Communication for the ISSS 47th Annual Conference):

General System Theory. The concepts, principles and models that are common to all kinds of systems and isomorphism among various types of systems.

System. A group of interacting components that keep some identifiable set of relationships with the sum of their components in addition to relationships (i.e. the systems themselves) to other entities.

Subsystem. A greater system’s component, is made up of two or more interacting and interdependent components. The subsystems of a system interact in order to attain their own purpose(s) and the purpose(s) of the systems in which they are embedded.

Model building. A disciplined inquiry by means of which a conceptual (abstract) system’s representation is constructed or an expected outcome/output representation is portrayed. There are models of function structure (like a still picture) and models of processes (like a motion picture).

Function. Denotes actions that have to be carried out in order to meet system’s requirement and attain the purposes of the system.

Human activity system. A system with purpose, that expresses some human activities of definite purpose; the activities belong to the real world.

Viable system model. It is a system able to maintain a separate existence, capable of maintaining its identity and transcend independently.

Environment. The context within which a system exists, includes everything that may affect the system and may be affected by it at any given time.

Variety. Number of possible states that a system is capable of exhibiting (Beer, 1979).
VSM approach to ERP systems

1. General conceptual model of a production system.

The old philosophic Aristotle ‘s model of the four causes helps to begin the construction of a model of production system as follows:

![Fig.1 Four Causes Model](image)

<table>
<thead>
<tr>
<th>Aristotle cause number and name</th>
<th>Production System equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.- Original</td>
<td>Matter, Energy and Information (MEI) input</td>
</tr>
<tr>
<td>2.- Formal</td>
<td>Transformation of MEI</td>
</tr>
<tr>
<td>3.- Final</td>
<td>output approximating to the real third cause</td>
</tr>
<tr>
<td>4.- Efficient</td>
<td>Management of causes one, two and three.</td>
</tr>
</tbody>
</table>

The above initial model can be improved up to become the Beer’s Viable System Model (VSM) (1979, 1985, 1994, Espejo & Harnden, 1989) to produce a better representation of an actual Production System including fundamental functions which are also ERP functions.
VSM approach to ERP systems

The VSM presents a new way of looking at an organizational structure. It is a recursive model in which each successive unit is nested within the next larger one. It is a pre-eminent way to manage variety. It is a logical structure which differs from a classical hierarchical organizational chart but helps management to organize effectively the Production System.

According to Guo & Yolles, (2006:15) “organizational theory and managerial wisdom suggest that, in order to survive and flourish, organizations must be compatible with their environments, which include all external social, economic and political conditions that influence their operations”

To be compatible with its environment means that a production system needs to process the variety of its environment to be equal to the variety of the system itself and the variety of the system to be equal to the variety of its management. This process is represented in the theory of viable systems in which the ability of the system to survive depends on its ability to create requisite variety (Ashby,1956; Ashby, 1964 in Yolles, 2007).

The Viable System Model sets out the necessary functions of operation/ implementation, coordination, auditing/ control, intelligence and policy that must be present in any viable enterprise and suggests what information systems have to be in place to support viability (Gregory, 2007).

Enterprise Resources Planning (ERP) is an information system that helps production systems to reach viability through several modules that process data and information as close to real time as possible and directs the information that flows around the various communication linkages shown in Fig. 2 and 3.

A viable system “is a system with an identity and purpose which is, in principle, capable of surviving its appointed time, whether definite or indefinite” (Leonard in Beer, 1994:347). The VSM is made of five subsystems/elements that in this paper are designed as 1)operations management, 2)coordination, 3)auditing/monitoring, 3)production management, 4)general management and 5)board of directors.

In a Viable System Model, System Four is concerned with the future (the outside and then: Budget of long range forecast and marketing) as asposed to system three’s concern with the present (inside and now: the best integration and coordination of existing resources, production logistic such as master production schedule, resources requirement planning, materials & capacity).

Sales and operation management is a typical system one function managed by system three, monitored by system 3* and coordinated (avoiding conflicts) by system 2.

Following Jackson (2000: 158-162) and Leonard (2006, 2007) let see how the modules of ERP help to perform the functions of the VSM’s five systems.
VSM approach to ERP systems

Fig. 2. General Production System Model based on VSM

Fig. 3. Details of interactions between System One and its environment (customers, suppliers and shareholders, communities)
VSM approach to ERP systems

**System 1**
The system one of a production system produces the system and consists of the various components directly concerned with carrying out the tasks that the production in a system is supposed to be doing, such as the tasks performed by some of the following ERP modules, shown on Table 2:

<table>
<thead>
<tr>
<th>Table 2. ERP’s Modules for System 1 of VSM.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sales and operation management (SOP)</td>
</tr>
<tr>
<td>3. Quality Function Deployment (QFD)</td>
</tr>
<tr>
<td>9. Shop floor Control (SFC)</td>
</tr>
<tr>
<td>11. Suppliers Relationship Management (SRM)</td>
</tr>
</tbody>
</table>

Each manufacturing department is connected to the wider management system by the vertical communication channels to receive instructions and to report performance, preferable on standard forms (Landvater, 1989). In order to be viable systems, each manufacturing department should be autonomous and be able to make its own decision.

**System 2**
This system has a coordination function whose main task is to assure that the various manufacturing departments of a production system act in harmony. It is the system 2’s job to overseer the interaction between departments and to stabilize the situation to obtain a balance response from system 1. Normally this coordination function is located inside the Manufacturing Engineering office and uses some modules of ERP such as those shown on Table 3:

<table>
<thead>
<tr>
<th>Table 3. ERP’s Modules for System 2 of VSM.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Production Scheduling (MPS)</td>
</tr>
<tr>
<td>- Work procedures / Bill of processes (BOP)</td>
</tr>
</tbody>
</table>

**Systems 3 and 3**
System 3 is a command control function. It interprets policy in the light of internal data from system 2 and monitoring or auditing reports from system 3*. The task of the last one is to give system 3 direct access to the state of affairs in the operations of system 1. Through this channel, system 3 can get immediate information, rather than relaying on
VSM approach to ERP systems

information passed to it by the localized management of production departments. For example to check directly on quality, maintenance procedures, employee morale, etc.

The ERP modules that can help system 3 to command and accomplish control functions are shown in Table 4:

Table 4. ERP’ Modules for System 3 and 3* of VSM.

<table>
<thead>
<tr>
<th>Shop Floor Control (SFC)</th>
<th>Financial Business Modules like:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing Execution System (MES) (to control and monitoring of plant-floor machines and electromechanical systems)</td>
<td>Activity Based Costing (ABC) to get real cost of finished products or services</td>
</tr>
<tr>
<td>Input – Output control and Production Activity Control (PAC) (to control details of production flow)</td>
<td>Accounts Payable (AP),</td>
</tr>
<tr>
<td>Human Resource Management (HRM) (for payroll, time management benefits administration, etc.)</td>
<td>Accounts Receivable (AR),</td>
</tr>
<tr>
<td>Plant and Equipment Management (FA) (Fixed assets management)</td>
<td>General Ledger (GL), (for controller, accounting, auditing, internal control, taxes reports, etc.)</td>
</tr>
<tr>
<td>Shop Floor Control (SFC)</td>
<td>Fixed Assets (FA), (for depreciations replacements)</td>
</tr>
<tr>
<td></td>
<td>Payroll (PR), for salary administration, social security,</td>
</tr>
<tr>
<td></td>
<td>Profit and cost center accounting etc.</td>
</tr>
</tbody>
</table>

From the accountants and financial perspective, there should be one of two fundamental objectives in a production system. One is to obtain the capability to produce a product or service that can be sold at a profit represented by A/R, A/P, F/A, etc. The second, is to improve an existing product or service so as to improve performance and customer acceptance, or reduce cost (with the help of “ABC” lean practices, etc.) without sacrificing customer acceptance either of which would lead to higher profits.

From the information processing point of view, the capacity of managers in system 3, of carrying out the control function, needs to be in balance with the current information flowing through the three incoming channels: 1) Coordination from system 2) auditing/monitoring from system 3*, and 3) command from system 1.

Systems 2 (coordination), 3* (monitoring) and 3 (production management) are highly dependent on timely and accurate reporting of what is happening in system 1 (operation management, manufacturing operations and its environment).

It makes no sense to install and expensive data collection subsystem of ERP if the data are not close to real time as possible (Turbide, 2007). The big dream of accountants is not to be faced with the “month end” syndrome and real time data approach to a solution because the ERP systems are updated all the time (Currant & Keller, 1998). ERP changes the accountants’ role in system 3 because they have more time to assist management in system.
VSM approach to ERP systems

3 as general advisors who can use the numbers to reduce variety and improve management of system 1. Real time data are subject to statistical filters of variety and processes to help achieving a better management of the system 1’s variety.

Real time data contribute to auditing/monitoring coordination and control of system 1 through some additional ERP’s modules and functions such as:

- Advanced Planning System (APS)
- Available to promise & capable to promise functions
- Production Activity Control (PAC)
- Inventory Management (IM)

System 4
System 4 is the research and development function of a production system, it has two main tasks:
1) Translate Instructions and reports between system 5 Board of Directors and the lower – level systems.
2) To capture all relevant information for the production system, about its total environment.

If the production system is to be viable and effective it has to, somehow, match the variety of the environment in which it finds itself. To do this it must have a model of the environment that enables predictions to be made about the likely future state of the environment and allow the production system to respond in time to threats and opportunities.

System four is the point where internal and external information can be brought together. Activities such as Strategic Planning, Market research, research and development and public relations should be located there.

The ERP modules that can help perform the tasks of system 4 are shown on Table 5:

The data base of the Human Resources module (HR) helps to build a portfolio of human resources, evaluated with high potential, for HR Requirements planning in order to have the right managers in the right amount and in the right time.

The Advanced Planning System/Master Production Schedule (APS/MPS) are feed forward systems which processes current information of operations with future ideals and adjust the output model accordingly.

Table 5. ERP’s modules for System 4 of VSM.

<table>
<thead>
<tr>
<th>Human Resource HR</th>
<th>Advanced Planning System (APS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Life Cycle (PLC)</td>
<td>Long Range Forecasts (LRF)</td>
</tr>
<tr>
<td>Legal and Fiscal Planning</td>
<td>Business Planning under various scenarios</td>
</tr>
<tr>
<td>Union and Community Relationship</td>
<td>Legal Issues</td>
</tr>
</tbody>
</table>
VSM approach to ERP systems

One of the most important responsibilities of system 4 is to keep adaptation mechanisms of the production systems with its future environment, represented by groups of investors shareholders, governments, unions, communities, etc.

System 5
System 5 is responsible for the direction of the whole production system; it is where identity and coherence are focused by the board of directors.

System five’s activities include formulating policy on the basis of all information passed to it by system 4 and communicating the policy downward to system 3 for implementation by the production departments.

System 5 must ensure that the production system adapts to the external environment while maintaining an appropriate degree of internal stability. It is the thinking part of the production system. There are no modules of ERP to help activities of system 5 it is recommended for developers of ERP systems to design modules for consensual agreements, strategies and policy based on methodologies such as Syntegrity from S. Beer, (1994) Interactive Management from J. Warfield (1994) or CogniScope from Christakis (2007) Algedonic information coming directly from system 1 to system 5 helps to manage urgent critical situations.

2. Recursion level.

Recursion level, some times also called level of organization, is a holarchical set of entities whose properties characterize the level in question. A given entity may belong to any number of levels depending on the used criteria to link different levels “nested above and below”. Fig. 4 presents 3 recursion levels for a global production system.
VSM approach to ERP systems

Fig. 4. A global production system with 3 recursion levels

This systemic concept helps understanding the development of ERP systems since the old inventory control systems through Materials Requirement Planning (MRP), Manufacturing Requirement Planning (MRP II), Supply Chain Management (SCM), up to Enterprise Resources Planning (ERP).

In the old times, most inventory systems of raw materials were managed by statistical techniques, because of the lack of the vision of a higher recursion level. After 1975, there were two alternatives: a) statistic inventory control (or order/quantity point technique); b) materials requirement planning (Turbide, 2004).

The theoretical work in inventory management that has been done during the past decades is generally confined to the models of Order Point and Order Quantity. Order point was a fundamental inventory management concept of raw materials when the demand was perceived as probabilistic, such was the case when the recursion level is only considered at warehouse level, but if the recursion level is raised to include the production unit and the marketing function, this technique is not valid because the demands of parts and raw
materials become deterministic (Fogarty, 1994; Blackstone, 2004). The previously described situation is equivalent to say that a new attribute called “dependent demand” emerged in the enlarged system.

3. Emergence

Emergence is the appearance of new characteristics exhibited on the level of recursion in question, in this case, the full production system, but not at the components such as the raw material inventory, design engineering, manufacturing engineering, sales, etc.

The new characteristics that should be considered, not only for inventory management but for management of the total MEI flow, are:

*Independent demand.*- This demand is unrelated to the demand for other items, particularly higher level assemblies, spare parts for finals products. Demand is defined independent when it is not a function of the demand for other inventory items. This kind of independent demand must be forecast.

*Dependent demand.*- This kind of demand is directly related to, or derives from, the demand for other items or final products. Such demand can, of course, be calculated. Dependent demand doesn’t need and should not be forecasted. It can be determined from the demand for those items to which it is compound (such as raw materials or purchased component parts) (Orlicky, 1970: 228-229; Plossl, 1994).

The discovery of these two characteristics made by Orlicky in 1970 was expressed by him as a production management principle: “The nature of the demand is the key to inventory control technique selections and applicability”.

Since then the demand of the final products (or service parts) in a production system may have to be forecast, but none of its component’s items, (including raw materials) need to be forecasted separately, it can be calculated from the final product forecast figures or firm sales, using the several algorithms developed by marketing research profession and the software industry since then.

Another relevant emergence situation happened around the integration of data: Production Information Systems like ERP are abstract models of real human activity systems, completely integrated. Therefore it is required that all data be also very integrated across all functions and must automatically link all related records in the systems.

In order to accomplish such design requirement for an integrated database, several database management languages were proposed, for example, the Integrated Data Storage (IDS) (Veith, 1970) was a tool to describe the complex interrelationships of production systems data, as well as , a programming language to organize , manipulate and maintain these interrelationships automatically in random access environment.
VSM approach to ERP systems

When the possibilities are realized they become needs, and this was the case with IDS, since 1975 all database management systems for production systems are relational and random access.

3.1 Materials Requirements Planning (MRP)

The first MRP systems were developed and deployed by General Electric Company (G.E.) in 1965, when the memory of mainframes was measured in Kb rather than Mb. The basic idea was to calculate the quantity and timing of production and purchase orders to support the MPS, using a simple four step process: 1.- Determination of the gross requirement from the master production schedule (MPS) and bill of materials (BOM), 2.- Find expected shortages by “netting” the requirement against availability, 3.- Determination of lot sizes from order-policy rules, then 4.- Backschedule to determine when to start the purchase or production order. The process continued level-by-level, until all requirements were satisfy.

The net calculation assumed that there was enough available capacity to complete all the activities within the specified lead times. To overcome this assumption, the capacity requirement planning (CRP) calculations were implemented and the MRP changed its name to Manufacturing Resources Planning (MRP II) (Petrof, 1992; Plossl, 1994).

3.2 Manufacturing Resources Planning (MRPII)

Manufacturing Resources Planning is the next step in the development of MRP, which basically consist of an additional algorithm to calculate capacity requirements of workers and machining centres, after material requirements are known. The logic of this algorithm is similar to MRP’s logic.

In this case the recursion level of VSM’s system one includes the production capacities of individual areas, machines and workers, which means that a bill of processes and actual database records of the available capacity will be necessary. The output reports of MRP II systems had been standardized by Landvater (1989).

3.3 Enterprise Resources Planning (ERP)

Enterprise Resource Planning is the next step in the development of MRP II which consists of the addition of several software modules to manage the main line business functions from Purchasing and Accounts Payable up to Shipping and Accounts Receivable, besides General Ledger, Payroll, Fixed Assets, etc.

3.4 Supply Chain Management (SCM)

This is the current state of ERP application which consists of a network of multiple ERP features to include the main line of suppliers, all of them working under a master production supplier-production-distribution-schedule. In this case the recursion level includes all the suppliers, production and distribution subsystems network, which works under local ERP’s systems harmonized via a communication network.
VSM approach to ERP systems

CONCLUSION

ERP systems by their own nature must be integrated. It is fruitless to attempt solving an integrated problem inside an integrated production system, with fragmented solutions. The VSM approach to ERP has permitted an understanding and appreciation of its strengths and weaknesses. Its understanding offers a better use of the ERP’s modules, its appreciation offers several opportunities to improve the designs of some modules or to create new ones.

The following are some examples of improvements:

1. Maintenance of equipment will be integrated, and its scheduling will be based upon capacity requirement planning, the current used capacity and the condition of the capacity items.
2. Equipment in use will report its conduction to system 3 as well as exactly what it is doing.
3. The actual modules of MES, AP and MPS. Will develop the functionality to recommend alternate processes based upon a defined enterprise strategy.
4. Activity Based cCst (ABC). Will be codified to become a tool for evaluating business activity.
5. DRP will integrate a transportation management system.
6. The actual state of development of ERP systems produce several benefits such as:
   a) Inventory reduction, b) Faster response time, c) Tight control of physical flow, d) Thorough control of information and financial flow.

REFERENCES


A DIFFICULT BALANCE: DECISIONS IN HEALTHCARE

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ABSTRACT
As humans, we have a number of basic needs: air, water, food, shelter. While these needs have not changed, our ways of meeting them have evolved with our societal arrangements. These changes in the ways our needs are met require infrastructure. Secondary to the emerging infrastructure that has come with increasing urbanization have been additional capabilities. Many people have come to see the provision of these capabilities as needs or rights. Among them is healthcare. While this author is in complete agreement with the ideal of making access to healthcare universal, the concept of what that means bears closer examination.

The World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” Such a broad definition may encompass any number of what will be referred to here as emerging needs, including the healthcare referenced above, as well as education, security and certain personal, political or religious freedoms, among many others. This state of physical, mental, and social well-being is also not likely to be defined in the same way for each individual, group, or culture. The balance in this system becomes difficult because there are multiple perspectives on what would constitute an ideal healthcare system, and perspectives may naturally change with circumstances.

The needs range across a very broad spectrum. We are entering a time of incredible divergence in our medical capabilities. On one hand we are moving toward an era of personalized medicine, in which we hope to provide medications for a specific genetic make-up. On the other hand, we are battling new or more resilient outbreaks of old foes such as cholera, dengue fever, and malaria. For participants in the healthcare system, including healthcare providers, public health practitioners, non-governmental organizations, and pharmaceutical companies, these questions and needs must be addressed on a global scale. As suggested by the WHO, we are a single planet whose populations have become interconnected enough to require the participation of all players in preventing disease and promoting health. The movement toward public-private partnerships, with implementation through grassroots organizations is likely to bring us the farthest in hearing the voices of the many, and understanding how to define, prioritize, and meet those needs. It is also important to consider the broader context within which that healthcare system works on a global scale. This paper will suggest ways in which systems thinking can “make a difference,” to echo the conference theme, by helping the various efforts in public health and individual health see the impact of multiple efforts together, so that they can be more complementary, or at the very least not work at cross-purposes.

Keywords: health, healthcare, healthcare system, global health, pharmaceutical, public health
THE GLOBAL ENVIRONMENT

As humans, our basic needs include air, water, food, and shelter. While these needs have not changed with time, our ways of meeting them have evolved with our changing social systems and consequent living arrangements. Our air quality sometimes needs to be controlled. Our water supply may be cleaned and supplied through plumbing, or if the water is not cleaned, it may have become a source of disease. Many of us need food supplies beyond that which we can grow or raise ourselves. Not all of us build our own dwellings. These changes in the ways our needs are met require infrastructure.

Secondary to the emerging infrastructure that has come with increasing urbanization have been additional capabilities. Many people have come to see the provision of these capabilities as needs or rights. Among them is healthcare. While this author is in complete agreement with the ideal of making access to healthcare universal, the concept of what that means bears closer examination.

The World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (Preamble to WHO Constitution, 1946). This broad definition may encompass any number of what will be referred to here as emerging needs, including healthcare, education, security and certain personal, political or religious freedoms, among many others. This state of physical, mental, and social well-being is also not likely to be defined in the same way for each individual, group, or culture. Interestingly, individual health security, with a focus on “the role of primary healthcare and humanitarian action in providing access to the essential prerequisites for health” is the planned topic of the WHO’s 2008 World Health Report (The World Health Report 2007, p 9).

In the meantime, the World Health Report 2007 is entitled, “A Safer Future.” It espouses, among other assertions, that “Today, the public health security of all countries depends on the capacity of each to act effectively and contribute to the security of all. The world is rapidly changing and nothing today moves faster than information. This makes the sharing of essential health information one of the most feasible routes to global public health security,” (p. 13). The emphasis here is on the prevention of pandemics, biological terrorism, and other global threats. However, examined more broadly, one interesting emphasis of this report is the pointed recognition of the responsibility of every country as a global player. There seems to be an emerging recognition of all nations as having a voice in our collective future as a planet. Similar arguments about the interdependence of peoples and power have been made in sociological circles as well (Piven, 2008).

As a global community, we seem to have evolved in our thinking. Generally discussions of global issues in the past started along the lines of separating “haves” and “have nots” from a material, industrial, or technological perspective. As the world became increasingly communicative internationally, and also moved through stages of relationships that included imperialism, colonialism, and defining “developed” and “developing” countries, we seem to have also moved through mindsets that went something like this, from the perspective of the “aggressors” or “philanthropists,” depending on one’s perspective.

1. We’re here to take over.

2. We’re from the Empire and we’re here to help.
A Difficult Balance: Decisions in Healthcare

3. We’re giving you everything you need to be just like us. What’s the problem?

4. Maybe you have some perspective on what’s needed.

Hopefully we are finally moving toward a fifth mindset that can look more like a full partnership, in which there is recognition of the roles, responsibilities, perspectives, legitimacy, and importance of all of the people involved in this complicated discussion regarding our collective future as human beings.

It is this interdependence of peoples, perspectives, and institutions that systems thinkers can and, I would argue, should represent. The broad thinking that captures the importance of each component in a total system can make an important contribution in advancing the discussion among diverse groups of healthcare providers and healthcare consumers. Systems practitioners who are part of the organizations that contribute to healthcare, as well as systems thinkers who sit outside of the organizations, have the potential to influence efforts by affording greater understanding of diverse perspectives and representing the influence that each may have on the total result that all can build together.

How “we” (humans) have that conversation inevitably comes down to a question of who represents the interests of many. Individuals may have the opportunity to participate in a system, but it is likely to be created by relatively few people, although it is sustained by all of us. Indeed, some argue that individuals should not be seen as the main driving force for health improvement at the population level (Beaglehole, 2005). While as individuals we often seem capable of negotiating relationships among diverse peoples, once we create officialdom, whether governments, religions, or healthcare systems, we seem to lose our ability to consider individuals, and in the process probably lose some of the benefit that was originally intended with the design of the institution itself. Nowhere may this be truer than with those institutions that are supposed to provide for our physical lives. From conception through death, whether maintaining health or fighting disease and deterioration, there are virtual strangers advising, cajoling, monitoring, measuring, praising, scolding, excising, implanting, or telling us to ignore those parts of our lives that we as individuals experience the most tangibly. Institutions and organizations attempt to meet the healthcare needs of those varied individuals, in different ways. Systems thinking can provide an informed perspective on the interactions among those organizations and institutions to help them work more effectively as circumstances and needs continue to evolve.

THE DIFFICULT BALANCE

The balance in providing healthcare becomes difficult because there are multiple perspectives on what would constitute an ideal healthcare system, and multiple players in providing it. In addition, perspectives may naturally change with circumstances. Worthy goals may include

- all people receiving some basic level of medical care
- all people receiving appropriate screening and monitoring to maintain healthy life
- sicker people receiving more intervention
- breakthrough medicines, technologies and surgeries continuing to be discovered and developed
- breakthroughs being available to everyone who could benefit from them
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- people of working age being able to continue to work and contribute to the economy, and therefore able to receive needed treatment and health maintenance
- children and adolescents being afforded all of the appropriate vaccinations and/or health maintenance and disease prevention possible so that they have an opportunity to live long and healthy, productive lives
- older people being provided all of the life sustaining treatments that exist, including remedies for the ailments created by our emerging lifestyles
- cures being found for the conditions we ourselves help create from the environmental problems caused by industrial changes and other human factors
- cures being found for all of the newly emerging bacteria and viruses that are resistant to the therapies we’ve already created
- universal access to clean water, nutritious food, and hygienic living conditions
- people having some choices in who provides care for them, what kind of care they want, and how and where they should receive it, since we know that simply making services available does not guarantee that they will be used optimally

These are a few of the many desirable goals on a wish list that could be as long as the list of people who inhabit this planet. But who gets to make those choices for the many? And which needs are the most important to answer first?

As suggested above, those needs range across a very broad spectrum. We are entering a time of incredible divergence in our medical capabilities. On one hand we are moving toward an era of personalized medicine, in which we hope to provide medications for a specific genetic make-up (FDA, 2007). On the other hand, we are battling new or more resilient outbreaks of old foes such as cholera, dengue fever, and malaria (Silberman, 2008; The Observer) These questions and needs must be addressed by a healthcare system or systems on a global scale. As suggested by the WHO report, we are a single planet whose populations have become interconnected enough to require the participation of all players in preventing disease and promoting health.

Healthcare is arguably a complex adaptive system (Rouse, 2007), capable of learning and self-organizing, with no single point of control. This perhaps gives the greatest hope of answering the many diverse needs. It is also the source of some of the greatest difficulty in making the system “work.” The people who create the technologies and treatments are not the people who determine some of the treatments needed for a patient and prescribe them, who in turn are not the people who often pay for them, who in turn are not always the people receiving the services and treatments. The functions of these groups could be simplified, for the sake of discussion, into supply, control, payment, and demand, with the realization that some groups serve more than one function. Each group often has a different interest or goal that it serves in order to contribute its part in the healthcare system. Furthermore, the groups may not all define optimal health in the same way. Some groups may be trying to maximize the benefit to the individual by prolonging comfort or trying to prolong life. Other groups may be trying to ration limited resources to achieve a societal goal. Some may be trying to maintain profits for shareholders or minimize costs for funding agencies. Some groups may be trying to meet the needs for the greatest number of people, or for the people deemed to be able to help their society the most, e.g., by contributing to the current or future economy. It is easy for these objectives to come into conflict, and for each party to see only part of the picture. In the current environment, given
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the institutions available, each objective and perspective has legitimacy that needs to be recognized if genuine progress is to take place toward finding solutions to current and emerging health issues. Systems thinkers within, or working among, these organizations can provide a more objective view of the dynamics in the healthcare system and the interplay of groups and their interests.

THE LESSONS FROM HIV

We learned many lessons about the interplay of culture and healthcare in the early fight against HIV. The virus spread through diverse populations, mutating rapidly. Many voices clamoured to be heard. Patients were frightened and desperate. Doctors were fighting something they hadn’t seen in medical school. Researchers frantically worked to find the organisms and mechanisms responsible for causing illness and death. Pharmaceutical companies, biotechnological firms, research institutes and governments tried to develop treatments and prevention based on emerging information. Conferences featured late-breaking sessions so that the very latest discoveries could be shared. As knowledge grew regarding the cause of AIDS and the potential treatments for HIV, patient groups and advocates became vocal about their priorities for the discovery and provision of treatment. There were demonstrations trying to force more rapid approval of medicines, movements to increase production of vaccines, attempts to promote barrier contraceptive use and abstinence, battles over the production and distribution of antiretroviral therapies, and a realization that we had entered a new age of pandemics capable of reaching around the globe.

Those patients and their supporters who were well-educated and/or well-connected in demographic communities and through the internet were able to transform doctor-patient relationships into partnerships seeking cures and more effective treatments. Some patients were presenting their views at medical conferences. Some patients and their advocates were helping to promote participation in clinical trials. Some patients and doctors experimented with herbal treatments and health regimens in conjunction with antiretroviral therapies. But these were not the only faces of the pandemic. There were so-called disenfranchised populations as well. The patterns of infection and disease differed among patients, as did their levels of trust in the medical community. There were accusations of HIV having been engineered to wipe out segments of the population. There were disputes over whether HIV caused AIDS. There was increasing realization that in addition to the obvious human tragedy for the individuals and their families, this pandemic brought to light many cultural issues beyond the disease itself – relationships among men and women, discussions of sexual taboos and lifestyles, economic issues around providing therapy for uninsured people where at that time were unlikely to be able to work again if they ever had, issues of discrimination, questions of moral high ground. These issues have not all been solved, but we began to understand that we were working in a much larger arena than one infected human body at a time.

In the meantime, attempts to make treatments and prevention more widespread in countries that were the most impacted by HIV and AIDS have been continuing to teach us important lessons about healthcare on a global scale. If cultural and social situations within a few countries were diverse, circumstances around the globe writ large the social and political variables that had to be considered. The impacts of the pandemic internationally were wiping out swaths of populations during what would normally be their most economically productive years. We (in the West) had to recognize that some of the circumstances that allowed for such devastation had been set up by outside countries’ influence on the more traditional family structures and economic arrangements of the countries now hit hardest by the pandemic. For example, the advent of trucking routes in Africa led to the separation of families for months at a time, with associated increases in prostitution and multiple sexual
relationships outside of marriage along the trucking routes. Declarations of traditional polygamy as taboo likewise left women and eventually children who would previously have been part of a family unit without economic or social support and with few ways for women to become educated and support themselves and their children. The sex trade in Asian countries that had previously been agrarian saw the rapid spread of HIV and AIDS, along with trafficking of younger and younger adolescents and children in the vain belief that they would be less likely to be infected. As each country assessed its own growing infection rate, some governments denied that HIV had entered its borders, some countries refused antiretroviral treatment even when it was offered at cost or free. Some countries confronted the pandemic head-on with educational programs and deep commitment to work with anyone who legitimately had treatments to test within their borders, as long as the benefits would remain after the clinical trials were over.

From the perspective of research and treatment, there were profound questions about potential unintended consequences. What if a vaccine were found and given widely, but it was only partially effective? Would sexual partners stop using condoms and other measures to prevent the spread of HIV and be at greater risk of infection? Furthermore, would we cause even more treatment-resistant mutations of the virus to be spread in this way, and ultimately make the pandemic even more intransigent? Likewise, if we began giving antiretroviral therapy, and then discovered that patients could not receive a steady supply of their medication, how much would we again be contributing to the spread of drug-resistant virus? We knew that consistent therapy was key to containing the virus for longer periods of time. From the beginning, there was an ethical obligation to all patients to treat them for life. Mobile and remote populations would always have to have access to ongoing supplies of medication. What if shipments of drug were seized and sold on the black market? How would we be able to track where the drugs went and what happened to the patients who received them, and how would we ensure that more drug reached the original patients in time? We had to think about, and sometimes build models to predict, how effective a vaccine or treatment would have to be, in what percentage of the population, over what period of time, to be more beneficial than harmful.

In addition to these broad issues, we had more specific concerns around getting medicine to patients on the ground. The vaccines and therapies needed to work in predominantly different mutations of the virus than those that were found in Western populations. Assuming that they worked in the laboratory, there were also fundamental aspects to delivering successful ongoing treatment in a hospital, clinic, and/or village. Many of the regions needing therapies had tropical climates that could affect the stability of the medicines and vaccines. In other words, the medicines had to be tested to see if they would become ineffective due to chemical breakdown in extreme heat and humidity. As described above, it was also imperative that patients who started on therapy remained on it. They would have to have blood tests to ensure that the medications continued to work, and would have to be given new therapies when the old ones stopped working. The tests that would check the amount of virus in their bloodstream likewise had to remain chemically stable in tropical climates and had to be inexpensive enough and uncomplicated enough to be able to reach more remote local clinics rather than just being used in metropolitan hospitals if use were ever to be widespread. The needles that would be required for blood tests and vaccines were designed for single use, which was impractical in a place with few resources. Methods had to be developed to sterilize and reuse equipment. Patients also had to be found. With the vast fear of the disease and the strong biases against HIV within many local communities, patients were frightened of being tested and identified.

Ultimately, efforts around treatment and prevention had to work hand-in-hand. Cooperation among grassroots organizations, governments, employers, and peer networks within cultures and countries led to successful implementation of prevention and treatment campaigns. The
voices of the many had to speak to one another, and work toward solutions that were sustainable in the lives of patients and their families and communities. Uganda’s factories and Thailand’s military were two successful organizations that confronted their rising infection rates openly and worked to provide education, prevention and treatment. They were able to decrease their infection rates while infection rates continued to rise elsewhere.

Twenty-five-plus years into the pandemic, we have seen progress, with simpler tests, more widely available therapies, and increasing numbers of children born uninfected. However, there are still an estimated 33.2 million people infected with HIV as of December 2007. An estimated 2.5 million people were infected that year, and about the same number (an estimated 2.1 million) died of AIDS in 2007. About 2.5 million children under the age of 15 are estimated to be living with HIV. (UNAIDS, 2007)

GROWING EFFORTS

As our global consciousness has been raised, we have been targeting other areas of concern with more visibility and larger funds. These are sometimes collectively knows as the “neglected diseases” that still affect large populations. There has been some movement toward public-private partnerships to work on these diseases that have been eradicated in some areas of the world, while still ravaging others. Implementation of treatments and wider solutions for these health problems through grassroots organizations (The Observer, 2008) may be likely to bring us the farthest in again hearing the voices of the many, and understanding how to define, prioritize, and meet diverse needs. But it is unlikely to be a simple or speedy process. If we consider the broader context in which these diseases have been allowed to thrive, it is clear that healthcare is again part of a much larger milieu. As explained in a public health manual, “health inequities involve phenomena outside of science, scientific measurement and bureaucratic management.” (Hofricter, 2006). The myriad factors affecting healthcare discrepancies are part of a complex system that makes up a standard of living. Consider the following illustration, outlining the impact of social injustice on disease and mortality (Figure 1), as one example. The inclination for someone creating health policy might be to feel overwhelmed by the apparent need to try to fix everything, and perhaps to conclude that nothing practical can be done, or to try to focus on one thing that can be done, without necessarily considering the other elements. Either approach is likely not going to make much improvement. However, the role of systems thinking in “making a difference,” to echo the conference theme, could be in helping the various efforts in public health and individual health see the impact of multiple efforts together, so that they can be more complementary, or at the very least not work at cross-purposes.

For more of a systems approach, consider Figure 2. This second diagram is by no means a comprehensive picture of needs or infrastructure. Rather, it is meant to represent the various types of social conditions that often build together as change takes place within a society. What began as an understanding of basic infrastructure needed to deliver medicines on an ongoing basis to populations who live in remote areas is evolving into a greater understanding of how the interdependence of many aspects of society can work together. The model for each system, culture, society, or circumstance is likely to vary, but some fundamental possibilities are represented in Figure 2. Clean water and better nutrition alone can increase the health and resilience of a population. If healthcare, and presumably health, improve, then the population could increase, or decrease, depending on whether or how soon other factors such as contraceptive use are part of the available healthcare. Often an increased use of contraception affords women more of an opportunity for education. Likewise, healthier children may mean an increase in the need for schools, or larger schools, at the elementary and secondary level. An increasingly educated population can provide for more of an opportunity for technological development. Depending on the type of
technology and how it is introduced, it could have an impact on desired family size (e.g., fewer people needed for some types of work, more education needed for fewer children). Technology can also lead to greater demands on healthcare, for example, if hazardous working conditions or unhealthy environmental impacts result from increased industrialization. Outside forces such as epidemics may still have an effect on population size. Potentially, the effect could be smaller if adequate nutrition, clean water, and good healthcare are available. However, increasing mobility and urbanization can lead to faster and more far-reaching spread of disease.

The point of thinking about these interrelationships is not to halt change or limit access to it, but simply for participants, such as healthcare agencies, grassroots organizations, and governments, to begin thinking earlier about how the changes they are working toward might be implemented in the most advantageous ways in conjunction with one another. I believe that this is some of the promise public/private partnerships afford. With more stakeholders at the table, working together and potentially each working on a variety of efforts, there may be more opportunity for greater understanding and more far-reaching benefit.

This type of dialogue is needed in many areas, about many health issues, not just the ones in what we often term the “developing” world. Many developments continue in more heavily industrialized countries as well. A recent article in the Wall Street Journal highlighted the difficulties of paying for chronic diseases that are on the rise among aging populations, using Alzheimer’s disease as one example of what the paper characterized as, “a rising tension that pits the cash-strapped entities that pay for healthcare against patients and drug companies. The entities that pay for healthcare in Britain increasingly say their limited budgets are forcing them to weigh the benefits of treatments against their cost. Patients and drug companies say such rationing could deny useful drugs to people who need them.” At stake were the calculations that the National Institute for Health and Clinical Excellence (or NICE) had used in determining that a drug did not show enough effect to be included in its list of approved medicines for some patients. NICE was complying with the order to reveal its calculations, but added that the ruling would “increase the complexity of our drug appraisals in some cases and they may take longer as a result.” (The Wall Street Journal, 02 May 2008). Again, we have an example of those interested in trying to maintain a basic level of health for a population versus those who are interested in helping the individual. Philosophically, we can see the need for fair distribution of resources. When our loved one is involved, however, the picture can look quite different.

Beyond a specific issue of care for particular patients in a certain demographic, there is the more general issue of how to balance care across the demographics of a society. As with the issues in less industrialized areas of the world, the more heavily industrialized areas also have choices, which are likely to impact their future development. Serious questions arise as populations age and keepers of public funds try to calculate who is contributing to the resources that sustain people who cannot work or have retired. Factors that increase life expectancy versus those that increase or sustain productivity are invariably part of the equation. Healthcare agencies are increasingly aware of the need to encourage more participation from patients and potential patients to help in this balance. Healthier lifestyles and improved disease prevention can contribute to less demand on the healthcare system. But the potentially longer lives and greater demand for screening tests also need to be factored into the equation. Once again, different stakeholders may be involved in these separate but related areas of healthcare and more general welfare.
A Difficult Balance: Decisions in Healthcare

Social Structure

Class
Institutional Racism
Gender Discrimination & Exploitation

Power and Wealth Imbalance
(Absence of Democracy & Political Influence)

Globalization: Deregulation of Financial Inequities
Labor Market Inequities
Lack of Access to Quality Education
Lack of Access to Productive Resources & Social
Social Exclusion
Limited Social Welfare State

Social Determinants of Inequalities in Health

Lack of Affordable Housing
Job Insecurity
Exposure to Hazards

Poverty and Low Wages
Community Social Decay

Lack of Access to Transportation
Psychosocial Stress / Unhealthy Behaviors

Inequity in the Distribution of Disease, Illness, and Well-Being

Figure 1. How Social Injustice Becomes Embodied in Differential Disease and Mortality Rates. (F Hofrichter, 2006, p. 245)
A Difficult Balance: Decisions in Healthcare

Figure 2. Some Potential Outcomes and Covariates of Increased Access to Healthcare and/or Disease Prevention

The picture is unlikely to become less complicated in the future. With the advent of increasingly specialized treatments that are desired for specific subgroups of patients, or “personalized medicine,” we face the need for even more specialized technology, from basic laboratory research, to testing in animals and people, to manufacturing smaller quantities on a more specialized scale. Along with the specialized medicines and devices come the special tests to determine which patients should receive which treatments. In addition to the issues around privacy, including concerns regarding the level of personal genetic information that may become available and out of an individual’s control, there are other aspects that have to be considered by governments, industry, and the public. The development of medicines and devices is highly regulated. The evaluation of safety and efficacy are accomplished in large measure by statistical evaluations that in the past have
A Difficult Balance: Decisions in Healthcare

depended on clinical trials in patients deemed representative of the intended population for whom the treatments will become available. Even with strict controls, and extended studies after regulatory approval, rare events can occur when medicines are used in increasingly diverse populations. There is a continued effort to find better ways to predict rare events sooner, and hopefully understand how to identify patients who may be at greater risk from a rare side effect. But these methods often require large numbers of patients. With the advent of medicines specialized to very small groups of patients, we must consider how we will evaluate efficacy and safety, and how we (the collective “we” including patients and physicians) can balance the risk of what we know and what we don’t know about individuals, their genetic makeup, and what that implies for the medicines that will be of greatest benefit to them. We will also have to consider how many of these medicines will be available, based on the processes and resources that will be necessary to develop, evaluate, regulate, and pay for these specialized medicines. “We” includes patients, regulators, healthcare providers, and the public who will in some way have voting ability and the power of public opinion to say how their tax dollars, healthcare bills, and public research funds should be used.

As healthcare technologies continue to evolve, along with our definitions of desired health and basic healthcare needs, societies, cultures, and/or countries will have to determine the approaches and technologies that are the most appropriate for them. Decisions are made for populations through funding and regulation. Priorities may be set by political, religious and/or economic forces. The repercussions of these priorities can be examined to allow more informed decision making. Transparency will not be a panacea. There will be conflicting interests. We have not found ways to maximize benefits to everyone, all at once. It is doubtful that we ever will. It could be argued that it is not even desirable to be overly transparent about the value one is placing on some segments of society at the expense of others. However, the alternative seems to be a cacophony of voices vying for their share of the resources, not to mention the silence of those who may feel that there is no hope at all.

I believe that this type of dialogue is a huge opportunity for systems thinkers to become a much more public part of the discussion. With the advent of global communications through the internet and other popular sources, there is an unprecedented opportunity for more public discourse and far greater awareness of the complex issues that affect all of us as human beings. Ultimately, programs will be created and decisions will be made by finite numbers of people, but the more that those decisions can be informed by patients and populations who are the ultimate consumers, the closer we will come to achieving that difficult balance.
REFERENCES


*The Observer*. (2008) Sunday, February 17. It is the world's deadliest disease, killing more than 900,000 a year in Africa alone. But can Bill Gates's dollars create a vaccine that would save a continent's children?


ARCHITECTURE CASE STUDY IN TRANSFORMITY FACTORIZATION

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ABSTRACT

This paper studies the Giannantoni factorization of H.T. Odum’s transformity into dissipative and generative components. A dissipative component of architecture was developed in the author’s paper “‘Tropical’ Emergy and (Dis-) Order” at the 4th Biennial Emergy Research Conference, and is related to the number of surfaces used up in architectural construction, for example making walls out of bricks. A generative component was developed in the author’s paper “An Algorithm to Measure Symmetry and Positional Emergy of n Points,” presented at the 2007 annual meeting of the American Mathematical Society, New Orleans, LA and included the the ISSS 2007 Bulletin; the generative component is related to the number of equal distances created between different parts of a structure. There is some evidence of ordinality; for example higher-dimensional structures can have orders of magnitude more symmetry. Emergy maximization is analyzed as a constrained calculus problem which for maximization requires middle values of both dissipation and generation. For example a placement of bricks around a yard in a highly symmetric fashion may have high symmetry but if they are not connected, will not lead to a desirable architectural structure. Similarly connecting the bricks into haphazard walls may have high dissipation but without some symmetry of construction into regular structures such as rooms, will be considered a waste of materials. Some other questions such as evolution of biological and animal structure are discussed.

INTRODUCTION

There is a certain paradox in the search for maximum empower, in that emergy is based on used-up energy, so that it seems a more wasteful production process (with more used up energy) would be favored. A way out of this paradox may be offered by Giannantoni’s factorization of transformity into a dissipative part, which is based on used up energy, and a generative part, which is based on creative molding of energy into new types. In this way a process which merely uses up a large amount of energy without creating any new energy type would not necessarily be favored. Since Emergy = Transformity * Energy, taking the derivative with respect to time yields the equation: Empower = Transformity * Power, supposing Transformity is constant for a given process. Then a process has greater Empower if it has greater Transformity, for a given power use.
Architecture Case Study in Transformity Factorization

There are a couple relevant optimization problems, letting $T = T_d * T_g$, where transformity $T$ equals dissipative transformity $T_d$ multiplied by generative transformity $T_g$:

1) $\max (T) = \max (T_d * T_g)$, such that $T_d \leq A$, $T_g \leq B$, 
2) $\max (T) = \max (T_d * T_g)$, such that $T_d + c * T_g = C$. Here small $c$ is a scale change between dissipative and generative transformity, and big $C$ is a bound or limit. 
3) $\max (T) = \max (T_d * T_g)$, such that $T_d$ and $T_g$ are calculated dependent on specific placement of blocks.

1) The answer to the first problem is simply to take the largest possible value $A$ of $T_d$ and the largest possible value $B$ of $T_g$ and multiply them, to get $A * B$.
2) By calculus, the answer to the second problem is $T_d = C/2$ and $T_g = C/(2c)$, so that the maximum product $T$ comes out $C^2/(4c)$.
3) The third problem remains challenging. In the case discussed below with ten 4x2 blocks, the maximization could be taken over the space $(\mathbb{R} \times U(1))^2$, where $\mathbb{R}$ is three-dimensional Euclidean space and $U(1)$ is the one-dimensional circle of orientations from 0 to $2\pi$, with the constraint that two blocks cannot occupy the same space. Although this setup is the official way to state the problem, it seems intractable at present. However the first problem can provide a sound guide to solving the problem in the case of a local maximum.

The first problem is relevant if there is no “trade off” between $T_d$ and $T_g$, so that they can both be maximized at the same time.

The second problem is relevant if there is a “trade off” between $T_d$ and $T_g$, so that maximizing one of the factors decreases the ability to maximize the second factor.

In this paper the decision is made to measure dissipative transformity by the ratio of original surfaces of blocks divided by remaining block surfaces. If few surfaces are left, the denominator is low and the ratio (dissipative transformity) is high. Generative transformity is measured by the number of pairs of equal distances between blocks of the resulting structure.

This study is very limited in that it does not study the “Use Case,” of architecture, or what the structure is designed for. These questions involve the placement of doors and windows and repeated pathways, which involve patterns, or cycles, in the time or fourth dimension. It is hoped later studies can extend the calculations to these essential questions. It would seem the most symmetry could be obtained in the 4-dimensional case by simply letting things stay the same from one moment to the next; however as H.T.Odum stressed and (Pico, 2002) points out, things are always decaying on their own, so that it takes feedback (change) to keep things to appear to stay the same, whereas they thus are not actually staying the same.

For the simple cases analyzed here, it seemed that problem 1) was sufficient to handle the architectural structures involved, i.e. that it was not necessary to worry about “trade offs,”
Architecture Case Study in Transformity Factorization

or, stated otherwise that it was possible, locally, to maximize both types of transformity $T_d$ and $T_g$ at the same time.

MODEL CALCULATIONS

It was decided to limit the study to ten uniform 4x2 LEGO blocks. Each such block has an initial dissipative transformity, based on its being 8 cells (each cell with 6 sides) combined together, of $6 \times 8 = 48$ incoming sides divided by 28 resulting sides (8 top, 8 bottom, 12 lateral), or $T_d = 48/28 = 1.714$.

The generative symmetry is based on putting one point at the center of each 2x2 block, or two points for each 4x2 block. The two points in each 4x2 block define an orientation. If the blocks are scattered randomly in space, the only equal distances will be the distance between the two points of each block. (Here the definition of random is that there are no more pairs of equal distances. This situation is somewhat hard to obtain; for example if any two of the blocks are parallel, it will create at least another pair of equal distances.) The minimum number of pairs of equal distances will then be the combination of ten things taken 2 at a time, or $C(10,2) = 10 \times 9 / 2 = 45$, since any two blocks create a pair of equal distances, based on the common separation of their two internal points.

As a consequence, the product $T = T_d \times T_g$ will always be at least $1.714 \times 45 = 77.14$.

Now what about maximizing $T$—various configurations create local maxima; it is claimed these are the structures that appear in architecture. Small changes in these structures decrease BOTH the dissipative and generative transformity. The following structures are considered:

1) straight line (1-dim)
2) square outline (3 blocks across each side, like foundation outline of a square room) (2-dim)
3) solid rectangle (4x5, like a roof or wall) (2-dim)
4) solid bench (5 adjacent blocks on bottom level and 5 adjacent blocks on top level) (3-dim)
5) pillar (5 levels of 2 adjacent blocks) (3 dim).

There is a complication with 3-dimensional structures since LEGO blocks are not cubical; the side length of a 2x2 block is 5/8 inches, but the height is only 3/8 inches. This difference causes 4) and 5) above (both in some sense 2x2x5) to come out with different values. The results of the transformity calculations are as follows:

<table>
<thead>
<tr>
<th>Structure</th>
<th>$T_d$</th>
<th>$T_g$</th>
<th>$T = Product$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Straight line</td>
<td>480/244 = 1.967</td>
<td>1140</td>
<td>2242.62</td>
</tr>
<tr>
<td>2) Square outline</td>
<td>480/240 = 2.000</td>
<td>1163</td>
<td>2326.00</td>
</tr>
<tr>
<td>3) Flat solid rectangle</td>
<td>480/196 = 2.448</td>
<td>1992</td>
<td>4878.36</td>
</tr>
<tr>
<td>4) Solid bench</td>
<td>480/136 = 3.529</td>
<td>1052</td>
<td>3712.94</td>
</tr>
</tbody>
</table>
5) Pillar  \[\frac{480}{112}=4.285\]  1595  6835.71

Interestingly, any slight change in the above structures typically decreases both the dissipative transformity and the generative transformity at the same time. The following results indicate the result of the given slight change in the above structure.

<table>
<thead>
<tr>
<th>Altered Structure</th>
<th>Td</th>
<th>Tg</th>
<th>T= Product</th>
<th>% decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Break line in two</td>
<td>[\frac{480}{248}=1.935]</td>
<td>1050</td>
<td>2032.25</td>
<td>9.3</td>
</tr>
<tr>
<td>2) Move one side over one unit</td>
<td>[\frac{480}{252}=1.904]</td>
<td>851</td>
<td>1620.95</td>
<td>30.3</td>
</tr>
<tr>
<td>3) Move one 2x2 block out</td>
<td>[\frac{480}{204}=2.352]</td>
<td>1902</td>
<td>4475.29</td>
<td>8.2</td>
</tr>
<tr>
<td>4) Move one 2x2 block out</td>
<td>[\frac{480}{152}=3.157]</td>
<td>983</td>
<td>3104.21</td>
<td>16.3</td>
</tr>
<tr>
<td>5) Move one 2x2 block out</td>
<td>[\frac{480}{128}=3.750]</td>
<td>1446</td>
<td>5422.50</td>
<td>20.6</td>
</tr>
</tbody>
</table>

These results depend significantly on exactly how the pattern is broken, since the web of equal distances varies according to how exactly the block is moved; however the general idea will stay the same. In particular the case 2 in which two breaks were made in the square to move the side over has considerably more loss of transformity than the other cases with only one 2x2 block moved.

Remark 1: If cubical stacking were allowed (versus 3 to 5 ratio), the pillar case 5) would come out even more than the rectangle case.

Remark 2: The symmetry calculations Tg are based on one of the author’s algorithms, for which a patent is applied for.

**DISCUSSION**

The results seem to follow the general outline of architecture, that certain structures--such as line, square, roof, pillar, and so on—representing local maxima of transformity, recur. Even slight deviations from these structures—a hole in the roof, a crack in the pillar—cause significant discomfort, i.e. decrease of transformity, mostly due to the generative (here symmetry) factor Tg.

There is also pause for thought in that the final transformities of the local maxima may not differ that much (4878 for roof versus 6835 for pillar), although any pathway from one to another (even straight line to square) may require an almost complete breakdown of transformity toward the minimum of 77.14 as structures are decomposed and re-assembled.
Architecture Case Study in Transformity Factorization

Thus the pulsing of one ecosystem or culture to another of nearly equal or greater transformity may go through the valley of chaos. This fact raises another question of how maximum empower might actually be achieved.

CONCLUSION

The simple results of this paper did not require the “trade off” theory of calculus; however more complicated cases would seem to require such trade offs. For example a house cannot be built only with a roof; it also requires pillars to hold up the roof. Thus the theory requires the further development of “Use Case” via time-varying or four-dimensional structures, to obtain practical results. It is believed, although results from one- to two-dimensional cases in this study only increased maximal transformity by a factor of about two, that higher-dimensional cases (such as four) may increase transformity by orders of magnitude. Only further study can determine if this possibility occurs. Also the question arises if symmetry per se can measure ordinal increases in transformity.

In terms of animals, the existing set of fauna seems to correspond to the local maxima of the architecture case study, as somehow giving at least local maxima of empower, in the sense that any small change in the structure of the animal is likely to cause problems for the animal.

ACKNOWLEDGMENTS

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SYMBIOSIS AS A METAPHOR FOR SUSTAINABILITY PRACTICE IN HUMAN AFFAIRS

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ABSTRACT

This concept paper is an exploration of various symbiotic relationships and their potential relevance for the organization and conduct of human affairs. Many types of symbiosis exist: between plants, between plant and animal life and between different animals. They contribute to protection and defense, cleaning, reproduction, nutrition, transportation and illumination. Some symbiots are so tightly coupled that they are not able to exist, or exist in the same form, separately. Others can exist separately but they are less viable alone than together. Still others benefit from but do not depend upon the relationship. All seem to provide complementary features and strengths that either enhance the success and well being of both or impose a bearable burden on the non-advantaged partner.

We are seeking, and none too soon, new ways to make a difference in the achievement of sustainable relationships in human society and organizations and between human activity and the natural environment. A broader and deeper appreciation of symbiosis in the general public and among researchers in different disciplines may make a contribution to both innovation and a more effective application of existing knowledge and tools.

Keywords: symbiosis, yoyo model

INTRODUCTION

Metaphors and analogies from the natural world are a rich source of ideas for both the systems field and its ability to contribute to finding answers to social and organizational problems. Sometimes these ideas are based on or backed up by laboratory or field research; sometimes they simply offer potential insight. Seemingly simple situations may be revealed in all their complexity as in Maturana’s biology of cognition. Complex situations may be simplified by using simpler analogies, such as when the US Department of Transportation analyzed traffic flow as if it were a hydraulic system using Prigogine’s ideas.

Stafford Beer found these possibilities useful in his work in British steel long before the publication of the Viable System Model and Team Syntegrity process. In Decision and Control (Beer, 1966), he introduced what he referred to as ‘the yoyo model’. It tracks the process of moving from an insight, expressed as metaphor, between a managerial
Symbiosis as a Metaphor for Sustainability Practice in Human Affairs

situation and a scientific one. By selecting relevant factors, the model may be conceptualized and tested according to logic. If it meets that test a more rigorous formulation may be made that produces an isomorphism between the managerial and scientific situations. Finally, a scientific model, probably expressed in mathematics, may be proposed which applies to both. He gave an example of using a well-studied experiment in animal psychology – namely the learning curve of a rat learning to run a maze – to predict the ‘learning curve’ of a new factory as it reaches its output potential.

In this paper, it is my intention to consider examples of symbiosis as metaphors for designing and utilizing new or more wholistic ways to integrate current disparate activities and point the way toward an increasing appreciation of our interdependence within the natural world. Sustainability, in the long run, requires human life to re-conceptualize itself as part of nature, subject to its constraints and its opportunities. Symbiosis well illustrates these opportunities (Margulis, L. 1998) (Perry, N. 1983). From the bacteria in our digestive tracts to our place as part of the earth’s animal and plant kingdoms, we are symbiots embedded in a web of interconnections. We could not live without these relationships, whether or not we are aware of them. Awareness could, however, spur adaptation, innovation and a certain humility that would help us avoid more damage our planet and ourselves.

SYMBIOSIS

The notion of symbiosis appears to offer a particularly rich source of metaphors and analogies. It means, quite literally, living together. There are three main types of relation:

Mutualism – where both parties benefit, although not always equally or simultaneously

Commensuralism – where one party benefits and the other suffers no ill effects, and

Parasitism – where one lives off the other although if the parasite gets too greedy, both it and the host will die.

Its examples range from the general phenomenon of plant and animal life exchanging carbon dioxide and oxygen to the very specific that become essentially a new species. The most common example of this is when particular types of fungi and algae (some of which are no longer found in a free state) come together to form lichen. The strength of the relationships varies from obligate or ‘crucial to their survival’ to ‘beneficial but not necessary’. Many relationships fall between these two extremes.

Human beings have been learning, sometimes to their cost, about the ways in which they are connected within the web of life. Given the increasing impact of human activities on the natural world, learning more about these connections has become a matter of survival. Humans need to both become more aware of the risks being run and the measures needed to reduce or counteract them. Learning how symbiosis works can provide both specific ways to improve survival or quality of life and a general appreciation of the range and strength of interconnections and relationships. In common with other organisms, human
Symbiosis as a Metaphor for Sustainability Practice in Human Affairs

beings are required to adapt to changes in their environment and often to find new ways to survive. Like many living things, these adaptations include responding not only to absolute criteria but also to gradations in carrying capacity and time frames.

Organisms living in symbiosis perform a number of different, and sometimes multiple services for one another. A favourite and colourful example of multiple services is the relationship between the clownfish and the anemone. The anemone is stationary, and feeds by attracting and stinging prey. The clownfish is a mobile and attractive meal for many predators. But, the clownfish is able to form a relationship with an anemone that gradually allows it to build up resistance to the anemone’s sting and enables it to live without harm in close association with the anemone. When this relationship has formed, the clownfish attracts predators who are then stung by the anemone. The clownfish shares the anemone’s meal and, through its motions, keeps the water circulating and the anemone’s immediate area clean. Protection is provided by the anemone, cleaning by the clownfish, and nutrition by collaboration between them.

Let’s look at more examples of these services and where there might be analogies to human and social systems.

DEFENSE AND PROTECTION

In nature, organisms help each other avoid predators in several ways. The blind pistol shrimp and the goby fish divide responsibilities to mutual benefit. The goby fish can see and the shrimp can burrow or dig a tunnel that both it and the goby can use for shelter. The shrimp maintains contact by touch with the goby fish while both feed. The goby fish wiggles its tail when a dangerous predator is approaching. When the shrimp gets the signal it burrows and both take cover.

Hiding in plain sight characterizes the relationship between the sponge crab and red sponge. The crab breaks off a piece of sponge and hooks it to its shell. The sponge grows over and covers the crab’s shell providing camouflage. The advantage to the sponge is that it, as a filter feeder, it benefits from the constant change of water as the crab moves. It also gets extra nutrients from the crab’s leavings.

Anemones and different kinds of crabs collaborate in similar ways to that of the anemone and clownfish with the difference that the anemones live on the crab shells and the crab carries them from place to place and increases the anemone’s nutritional variety.

Mammals also engage in mutual protection. In Africa, the herds of impala antelope and baboons collaborate at water holes. The impala has sharper senses and can give warning when predators approach. The aggressive and territorial baboons will protect both their own groups and the impala.

This is comparable to the relationships that grew up between early humans and dogs. The dog has much more sensitive hearing and smell than the human and is much more difficult for a predator to sneak up on. The humans shared food and shelter with the dogs
and joined them in repelling attackers. This relationship changed over time and dog/human interactions evolved to take advantage of different circumstances. Herding dogs enabled people to graze sheep among hills not conducive to farming. They protected the sheep from predators and were able to keep them from wandering off and getting lost. Sled dogs extended the range of the Inuit into terrain where they could not otherwise have survived. In the present time that relationship has become both more general (many dogs are predominantly companions) and more specific (such as when the dog’s superior sense of smell is trained to enable it to perform search and rescue operations or sniff for explosives). The evolution of human/dog mutualism can serve as an example of the potential for refining and extending comparable interactions.

When we come to look at purely human analogies, we see some comparisons to symbiosis in nature. The Cold War between the United States and the former Soviet Union provided one. The United States and other western nuclear powers extended a ‘nuclear umbrella’ over NATO countries as well as South Korea and Japan. The mutual defense pact provided that the United States would regard an attack on one of these as an attack on itself and in return it received permission to operate military bases in these countries or receive other types of cooperation such as the Distant Early Warning or DEW line of radar stations in Canada, Greenland and Iceland. This type of collaboration, like that between the Impala and baboon is effective against a formidable and well-organized adversary. It is worth asking if such arrangements become counter-productive when the potential adversary is a small state with an unrepresentative or ineffective government or not a state at all. The possibility exists that the ‘umbrella’ strategy might now amplify rather than attenuate threats and increase the possibility for error.

Less problematically, collaboration among countries with respect to warning against natural disasters is effective. Weather satellites track hurricanes and cyclones and warn those in the path of disaster. Seismometers, supplemented by sensors on the sea floor attached to buoys give the alarm that a tsunami may be coming. Of course, messages must be received and acted upon to be effective. The current humanitarian crisis in Burma seems to have been exacerbated by the their government’s failure to communicate the warnings it received to its population, as well as its reluctance to open its borders to international relief agencies to assist once the storm had run its course.

**CLEANING AND WASTE DISPOSAL**

It seems that little or nothing is wasted in nature. What is surplus or bad for one organism often becomes another’s food directly or indirectly. While we are most familiar with bacteria breaking down dead plant and animal matter to enrich the soil, some of these relations are between organisms that actively seek each other out for cleaning.

Fish constitute the most numerous instances of cleaning. Since it is difficult if not impossible for many fish to remove their own parasites and necrotic flesh, a number of fish have evolved into roles of cleaners and clients. Even aggressive fish welcome smaller cleaner fish and allow them access to their skin and even their mouths and gills. Some fish even come to ‘cleaning stations’ and wait their turn with the cleaner fish. The
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senorita fish and cleaner wrasse are able to service hundreds of fish in a day. This helps the client fish stay healthy and provides a substantial portion of the diet of the cleaners.

On land, some species of birds form relationships with herbivores, eating insect’s disturbed by the movement of the larger animals, as well as parasites from their hosts. With the cattle egret and the oxpecker the herbivores benefit both from parasite removal and from the bird flapping its wings and drumming on its head when predators appear.

Formal and informal re-cycling provide actual and potential examples of ‘cleaning’ in human societies. Edward Burtynsky documented ship breaking in Bangladesh and the extraction of metals from e-waste in China. (Baichwal, J., 2006). As dangerous as these occupations are, they provide livelihoods for many. But, it is not only the scavenger occupations that provide opportunities for re-cycling and re-use. Second hand stores, swap meets, on-line exchanges like E-Bay and Craig’s list and, at a less ambitious scale, garage sales are venues for mutually beneficial exchanges. One person’s junk is indeed another’s treasure and both parties are usually satisfied with the exchange.

The ‘cleaning’ function is one of the most promising pathways to promote sustainability. Just about any industry’s waste product can be turned into a different product or into energy. The challenge is to find ways of doing this that are economical and that do not add further to environmental problems. This is an obvious source of green technologies and the jobs that would accompany them.

We may also look at symbiotic plants to compensate for human folly. One risk to people in former war zones is that spent shells that used depleted uranium to increase their penetration capacity remain on site and are a threat to the well being of plants and animals, including human beings. Dundee University researchers (Formina, F., Gadd, G. et al, 2008) have found promising evidence that free-living and symbiotic plant fungi can coat the depleted uranium surfaces and change it to a mineral form that is more stable and less likely to spread and be ingested. The potential for these fungi to perform a similar function in other soil polluted by metals is also a promising avenue of research.

**POLLINATION AND PLANT REPRODUCTION**

Pollination, performed mostly although not entirely by insects, transfers pollen from the male to the female plant. Insects visit the flowers for nectar and carry the pollen from one plant to the next. The symbiotic relationship between bees and the many flowers they pollinate has been receiving a great deal of attention these days because of the honeybee Colony Collapse Disorder that researchers are still trying to understand. A virus, pesticides and malnutrition (from a monoculture diet) and/or some combination of these have been suggested as culprits. What is clear is that a good proportion of the human diet depends on plants that bees pollinate. While it is possible for people to duplicate the bees’ function with small brushes as they are trying in China, it is far from a general solution. While it is by no means certain that unintended effects of human activity are responsible, the problem of colony collapse is a wake-up call that we cannot take insect pollination for granted and must take steps to protect this relationship.
Seed distribution is a related activity. Birds and animals that eat fruit and its seeds are mobile and carry the seeds away from the plant where they have a better opportunity to grow. As long as the seeds can survive the trip through the digestive tract, they may land on fertile ground.

Burdock and other thistles (some of which are actually called ‘hitchhikers’) are distributed by fastening themselves on to passing animals to drop or get pulled off in a new site. While the arrangement is of benefit only to the plant, most animals do not suffer ill effects.

In human society, pollination and seed distribution may also transmit ideas, sometimes by accident. Burdock, with it’s hook and loop characteristics, was the inspiration for the invention of Velcro. Many other innovations in human artifacts have been inspired by the close observation of nature. Among them are aerodynamic designs for planes and other vehicles, water and dirt repellant surfaces, building infrastructure and tools (Bluchel, K.G. and Malik, F. Eds., 2008).

A social equivalent of pollination and distribution is provided by venues for communication and the exchange of ideas in person, in print or face-to-face. Valuable innovations have often emerged when it has been possible to look at things from another angle or discuss a situation with people having different perspectives. Conferences, trade shows, business and student exchange programs and seminars where people have the opportunity to talk informally often lead to innovations. Businesses that depend on innovation often provide such opportunities from informal coffee hours to structured internal meetings. The observation that the conversations ‘later in the bar’ at conferences were often more valuable than the formal papers was one of the elements in Stafford Beer’s design of the Team Syntegrity process (Beer, 1994). Harrison Owen (Owen, 1997) who developed Open Space Technology wrote about a similar insight.

**NUTRITION AND DIGESTION**

In general, life is dependent upon on acquiring enough nutrients to survive and reproduce. Animals depend directly (as in herbivores) and indirectly (as in carnivores) on plant life. Different types of homeostasis keep things in balance. One is the (simplified) example of homeostasis between predators and prey. Predators need prey to survive but if they take too many, there are not enough prey to go around and the population of predators declines. With fewer predators, the population of prey rebounds and the cycle starts again. Prey, at the population level, benefit from predators because they take the weak and the sick and keep them from depleting their food supply and suffering population collapse.

The general symbiosis between plant and animal life can become quite specific. The green hydra, for example, ingests algae that migrate to a position under the hydra’s translucent outer skin. The algae are plants and produce oxygen and nutrients through photosynthesis. This provides the hydra with an additional food source when prey is
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scarce. Hydra can exist without algae but are more vulnerable to variations in food supply without the added contribution of the algae’s products of photosynthesis.

Cattle and other herbivores and their gut bacteria represent another type of symbiosis. They eat grass and other forms of cellulose, which they cannot break down themselves. Bacteria in the digestive tract that ferment the cellulose so that it can be digested perform that function as well as providing a source of protein for the cow. This fermentation process is what produces the methane gas that cattle expel. Although the details are less clear, human beings and their gut bacteria also seem to live in symbiosis.

In the plant world, bacteria enable legumes to convert the nitrogen in the soil to a form that plants can absorb. Crop rotation utilizing this nitrogen-fixing characteristic of legumes fertilizes the soil without the need for environmentally risky commercial fertilizers. Fungi attach themselves to the root system of trees, sharing in the nutrients produced by the tree and extending the tree’s root system to enable it to absorb more water and nutrients from the soil. This relationship is especially important in dense forests where there is strong competition among trees for root space. Without the added absorption power of the fungi, many fewer trees would survive.

Human beings have learned some painful lessons from interfering in the natural balance. Creating situations with numerous prey but few or no predators and over-fishing are just two examples. Generally, species that live close together have evolved in concert and neither overwhelms the others. Introduction, by accident or on purpose, of ‘exotic’ species such as rabbits, zebra mussels, ice plant and Asian bark beetles has had serious consequences for local species and the balance that existed among them and often for the human activities as well.

Monoculture food crops, growing food with chemical fertilizers and pesticides, using energy to transport crops that can be grown locally over long distances, over-packaging, growing corn and soy for fuel and driving up prices all contribute to increasing our ecological footprint in unnecessary ways and place additional burdens on the less advantaged. Substantial latent potential exists in current agriculture and aquaculture to identify and build upon symbiotic relationships.

Human beings need nourishment for their minds and hearts as well as their bodies. Too often, organizational practice emphasizes internal competition rather than collaboration and inhibits rather than enhances the sharing of information and the building of trust and cooperation. Other than creating a less than pleasant atmosphere, such practices may keep people from discovering opportunities for better products and services and closer relations with customers and suppliers.

ILLUMINATION

Luminescent bacteria may form symbiotic relationships with fish and squid. The fish live and receive nourishment inside their hosts. The hosts benefit because the light emitted by
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the bacteria attracts prey and enable them to see at depths where sunlight doesn’t penetrate.

In social systems, we may find an analogy to this type of symbiosis in that societies all over the world have been willing to support artists who create beauty, storytellers and philosophers. This is sometimes a tangible and sometimes an intangible form of illumination. People thrive with stimulation and opportunities for new learning. Exchanges among people and cultures has often stimulated both artistic and scientific advance. One may think of ancient Greece or of Italy at the time of the Renaissance. The insights and aesthetics that emerged in those times are still informing human society today.

CONCLUSION

Thinking again of Beer’s yoyo model, we can see that there are many comparisons that can be made between various types of symbiosis and ways forward that might reveal insights of help us to see ways of being that would leave smaller ecological and social footprints. With a more and more connected world, we see that actions lead to consequences that are sometimes far removed from the source. Many of these comparisons are at the level of metaphor and predominantly contribute new insights. Progress on others, especially in the field of bionics, may be more rigorous and proceed to the level of analogy or even a many-to-one mapping.

Although human beings can choose different ways consciously without waiting for good fits to arise through the slow process of evolution, we can appreciate what has been achieved in nature in all its complexity and try, with humility, to find comparable answers and adapt to our changing environments with a minimum of dislocation.

REFERENCES

SEARCHING FOR OURSELVES: A METHODOLOGICAL EXPLORATION OF
A SOFT SYSTEM DYNAMICS METHOD AS A SOCIAL LEARNING TOOL
FOR WATERSHED IMPLEMENTATION PLANNING

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ABSTRACT
Theories of environmental planning acknowledge that social-interactional dynamics contribute significantly to the complexity of environmental problems. Especially, the collaborative capacity to coordinate activities among diverse interests is crucial for successful plan implementation. However, environmental planning typically takes successful implementation as a given rather than as a problematic outcome. Consequently, we understand very little about how to measure the institutional capacities of communities to carry out plans. On a more practical level, if successful implementation depends on the coordination of multiple stakeholders, then we need an effective tool for learning how to join different institutional purposes. And if, as this proposal contends, common purpose is embedded in (rather than separate from) collective action, the implementation-planning tool will conform to a participatory action research methodology. Drawing on Rodriguez-Ulluma and Paucar-Caceres’ (2005) Soft System Dynamics Methodology, and informed by the cognitive model of institutions, I am proposing a Soft System Dynamics Method (SSDM) that combines the richness of Soft Systems Methodology storytelling and the rigor of System Dynamics (SD) modelling into a social learning tool for action planning. A central premise of SSDM is that socio-cultural values underlie patterns of social interaction. In watershed planning and management, the “environment” represents social goods but also contexts of social interaction where often tacit norms about roles and responsibilities are enacted and negotiated. In this sense, watershed communities are sociotechnical systems, or “communities of practice.” My dissertation research is a methodological exploration of SSDM as a social learning tool for watershed implementation planning. Three contemporary cases of watershed implementation planning processes will be selected to receive the SSDM intervention. The primary objective of the study is to explore whether and how SSDM promotes group learning about the institutional context and associated leverage points of watershed plan implementation. The study will also demonstrate SSDM both as a tool for developing middle-range theories of collaborative capacity and as an implementation planning tool for problem structuring and institutional design. This paper outlines the proposed SSDM and study design, arguing that a design view of systems can and should contribute to a participatory action research methodology for measuring and realizing group learning. Ultimately, it is hoped that SSDM represents a step closer to realizing C.W. Churchman’s vision of the “Singerian Inquiring System” where social learning is characterized by the synergistic integration of theory and practice, facts and values.
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Keywords: social systems design; social learning; action research; soft systems methodology; system dynamics modelling

INTRODUCTION

This paper proposes a Soft System Dynamics Method (SSDM) as a social and policy learning tool that promotes group learning about the institutional context of watershed problems. A central premise of SSDM tool is that socio-cultural values underlie patterns of social interaction. Since technical planning problems always occur in a particular socio-cultural context, it follows from this that ostensibly bio-physical environmental problems are mediated by values that operate as rules governing how stakeholders interact with one another. It is not simply that the environment represents certain “social goods,” such as clean water; environmental problems also become contexts of social interaction where often tacit norms about roles and responsibilities are enacted and negotiated. Watershed communities illustrate this integration of instrumental and social logic where stakeholders negotiate institutional claims with and through environmental practices and policies. In this sense, watershed communities are sociotechnical systems, or “communities of practice.”

Such a conceptualization follows a “design view” of systems that holds that purpose is embedded in (as opposed to separate from) patterns of interaction. If watershed communities embody particular sociotechnical purposes it also means that they can become problems in their own right: they can become “communities of malpractice.” That is, watershed problems may be viewed in terms of poor implementation of a good purpose or successful implementation of a poor purpose, including having no common purpose at all. A second premise of this paper is that successful implementation of a common purpose, whether or not that purpose is expressed in an explicit plan, requires coordination of diverse institutional stakeholders into a (sustained) pattern of interaction. Therefore, poor implementation, taken in this more general sense, reflects a conflict of purpose between a given watershed plan’s purpose and the larger community’s vision.

For any given watershed problem, the question then becomes: where does the problem reside: in the watershed plan (or lack thereof) or in the community of practice? The approach taken here asserts that the two aspects of the problem cannot be separated and that problem conceptualization depends on the level of perspective taken. Regardless of how a watershed problem is defined, the definition carries with it an implicit judgment of the values that are embedded and enacted in a community of practice. A planning response, for it to be meaningful, will similarly assume a particular pattern of interaction among stakeholders. It will, in other words, embody a common purpose. Thus, the entire process of reflecting on and responding to environmental problems is always ultimately driven by historically situated visions of what constitutes “the good society.”

Generally, environmental planning theory and practice overlooks the socio-cultural context of implementation because such a conceptualization implies a response that is largely absent in the repertoire of planners. Not surprisingly, the “problem of implementation” is often diagnosed and addressed by improving plans or planning
processes, depending on one’s training and bias. It is not that technical or process considerations are not important; they obviously are. But they are not, by themselves, sufficient to address the problem of implementation.

To address this deficiency in environmental planning, this paper proposes a Soft System Dynamics Method (SSDM) as a learning tool for stakeholder groups to reflect on the institutional challenges and opportunities of implementing watershed visions. SSDM adheres to a systems-informed Participatory Action Research Methodology (PARM) which asserts that implementation should be measured as an outcome in terms of particular patterns of interaction among stakeholders; that is, implementation can be thought of more generally and more dynamically as the overall behavior of a sociotechnical system. SSDM thus seeks to measure the collaborative capacity of watershed communities of practice in terms of the extent to which the community’s actual behavior pattern differs from a particular, desired behavior pattern, or “DBP.”

SSDM is based on a root definition grammar that integrates descriptive and prescriptive purpose and thereby encourages stakeholders to reflect on the socio-cultural values that drive problem definition and response. The rich picture format of the Soft Systems Methodology (SSM) enables stakeholders to collectively tell the “implementation story” which is then operationalized into a System Dynamics (SD) model. A significant benefit of SSDM is the discipline it imposes on thinking about levels of analysis regarding causality. Once a common purpose or DBP is identified, the group can begin to systematically vary and test for institutional factors that seem to be important determinants of system behavior. These leverage points can then become the focus of further inquiry and, eventually, intervention in the form of institutional design.

Thus, SSDM’s value is both theoretical and practical: it can contribute to middle-range theorizing about inter-organizational collaborative capacity while also serving as a tool for implementation planning. Ultimately, it is hoped that SSDM will contribute to the larger social learning project as envisioned by Churchman’s “Singerian Inquiring System” where theory and practice, facts and values, are integrated to synergistic effect.

**LITERATURE REVIEW**

Environmental policymaking’s current emphasis on managing rather than eliminating uncertainties was in fact anticipated by planning theorists who, starting in the 1960’s and early 1970’s, observed that planning problems are complex, or “wicked,” to the extent that there is no universal agreement on the nature of problems or on their solutions (Rittel & Webber, 1973). Since then, the emergence of Complexity Theory has also ushered in an increased awareness and use of modelling methods and technologies in planning (Byrne, 2003). Modelling emerged as a formal discipline within the Operations Research (OR) field and has been used in planning since the late 1950’s. True to its OR roots, modelling was primarily used to solve optimization problems within ostensibly technical domains, particularly within transportation. Since then, modelling and planning methodologies have followed parallel and at times mutually informative paths, with increased attention being paid to the complex interdependencies of “socio-technical systems.” Here, socio-technical systems are conceived as being composed of “hard” and “soft” elements, the former being amenable to optimal design considerations and the
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latter being concerned with values. For Byrne (2005) and others, Complexity Theory provides a systematic understanding of the context-driven nature of socio-technical systems that is rooted in an action-research-oriented modelling framework. Under this framework, stakeholders articulate a common purpose that organizes the joint exploration of problems and alternative futures. Because action-research-oriented modelling is sensitive to the local context of action, it is more likely to lead to an implementable plan (cf. also Friedmann, 2003)

But to date, socio-technical modelling in the environmental planning context has favored technical over social considerations. This technocratic bias assumes the more traditional form of focusing on technical aspects of the given problem. But it is also expressed as a tendency to reduce “value” considerations to quantified valuations of natural resources and other public goods (cf. Reed & Brown, 2003). For instance, the environmental justice discourse continues to be dominated by technocratic concerns with measuring “risk” (Rhodes, 2002). Similarly, in the context of Integrated Environmental Assessment (IEA), modelling is primarily expert-driven. Multiple Objective Analysis (MOA) or Multiple Criterion Decision Method (MCDM) methods are employed to solicit stakeholder valuations of environmental goods or services, which are then fed into (expert-driven) algorithms for selecting the “best” alternative scenario (Cai et al., 2004; Winn & Keller, 2001). Ecosystem marketplaces are also being implemented as experimental test beds that rely on the marketplace to calculate optimal allocations of economic activity by assigning a monetary value to “environmental services” such as clean water (Sterner, 2002). And recent work in mediated, or “collaborative,” environmental modelling focuses on measuring stakeholder perceptions and uses of the physical environment in terms of environmental and/or economic utilities in order to predict and evaluate different policies in terms of their social utility outcomes (Cockerill et al., 2006; Daniels & Walker, 2001; Innes and Booher, 1999; Mostashari & Sussman, 2005; Purnomo et al., 2004; van den Belt, 2004 Videira et al., 2003).

While stakeholder valuations of the biophysical environment are important, this approach is based on a narrow concept of “environment” that overlooks the importance of the socio-cultural environment of interaction. As a result, we understand very little about the social dynamics of environmental policy and plans. And yet planning is centrally about coordination of institutional stakeholders (Alexander, 1993). Recent theoretical work on eco-social systems, particularly within the framework of adaptive environmental management (AEM), is beginning to highlight the importance of social learning in collaborative environmental governance (Bouwen & Taillieu, 2004; Davidson-Hunt, 2006; Lee, 1993; Maurel et al., 2007; Pahl-Wostl et al., 2007)\textsuperscript{v}. Some attempts, popularized of late by the concept of “social sustainability,” have been made to measure the relationship between stakeholder views about one another and collaborative capacity (see, for example, Weber et al., 2007). These studies are to be commended for conceptualizing “collaborative capacity” as an outcome measure rather than as a given. But models of “collaborative capacity” are typically static and thus ignore temporal dynamics that may influence inter-organizational effectiveness. What is needed is a truly multidisciplinary and dynamic approach to the study of the institutional context of social practices, including plan implementation.
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Richard Scott (1995) identifies three basic models of institutions: the regulative, the normative, and the cognitive (cf. also Shinn, 1996). Neo-institutional economics concerns itself largely with the way governance structures economize transaction costs through regulation. The regulative model assumes that decision-makers are rational and follow an instrumental logic. In contrast, the normative model emphasizes the normative character of institutions. Adherents of the normative model of institutions focus on the formal and informal rules of interaction that evolve in the collective process of solving recurring problems (March & Olsen, 1989; cf. also Schein, 1990). The evolution of routine procedures compensates for the fact that individuals are “boundedly rational,” that is, limited in their ability to collect and process information (March & Simon, 1958). Decision-makers are assumed to follow a “logic of appropriateness” that specifies largely stable expectations for various roles in specific contexts.

While the normative model addresses the inadequacies of the regulative (and rational actor) model, critics point out that it does not account for agency in organizational decision-making. Advocates of the cognitive model of institutions emphasize the way that cultural meaning is internalized and enacted through everyday practice. They point out that while actors may be bounded in their rationality, they nevertheless are presented with choices that represent opportunities for critical reflection, calculation, and even learning (Schön & Rein, 1994; cf. also Burke & Reitzes, 1981; Rosenberg, 1979; Stryker, 1980).

The epistemological underpinning of the cognitive model of institutions is social constructionism. Social constructionism emerged in an attempt to resolve the structure-agency debate by asserting that discourses imbue problems with socially constructed meaning and that social actors strategically select from the available set of discourses in pursuit of their own interests. The choices which actors are given, their interests, as well as the outcome are to a large extent determined by prevailing socio-cultural structures of practice. But because cultural meaning is embedded in action, actors have a direct or indirect influence on those structures (Giddens, 1984).

Social constructionism has been influential in policy-analytic formulations, including Institutional Analysis and Development (IAD), which argues that policy actors make strategic decisions to form alliances and mobilize discourses or resources according to “structures of opportunity” which may themselves change as a result of these decisions (Ostrom, 1999; Rydin, 2003). Sabatier and Jenkins-Smith’s (1999) propose a similar marriage of structure and agency in their Advocacy Coalition Framework (ACF) which examines policy systems and subsystems. More generally, the “communicative turn” in policy analysis and planning theory during the 1980’s signalled an increasing interest in the communicative aspects of social action and generated new questions about social learning and institutional design (Hajer & Wagenaar, 2003; Hoch, 2007). In particular: if patterns of social interaction presuppose some learned system of communication (Bateson, 1958; Luhmann, 1984) and if social communication is itself at least partly contingent on the random confluence of social action, how can collective action among diverse interests be meaningfully obtained and sustained? This question has special relevance for the planning and management of common pool resources like water, where “defection” is always a real possibility (Hardin, 1968; cf. Axelrod, 1984; Dietz et al., 2003; Karkainen, 2002; Ostrom, 1999).
New institutional theorists that adhere to the cognitive model of institutions have begun to highlight the importance of culture or “communities of practice” in collaborative capacity, be it at the firm or societal level (Berger & Luckman, 1967; DiMaggio & Powell, 1983; Katz & Kahn, 1978; Meyer & Rowan, 1977; Meyer & Scott, 1983; Scott, 1992; Silverman, 1971; Smircich & Stubbart, 1985; Weick, 1993; Zucker, 1991). But while the cognitive model of institutions has informed work in organizational learning and development, most applications have been limited to strategic planning in the private sector (Banner & Gagne, 1995; Collins & Porras, 1996). And even within the private sector, most theoretical and empirical work has predominantly been concerned with single organizations rather than with (inter-)organizational fields.

There is currently a dearth of understanding of inter-(or “trans-“)organizational dynamics and the institutional conditions that promote collaborative capacity. To be sure, some promising lines of analysis that build on the Open Systems tradition have started to shed light on the influence of broader institutional fields on organizations in general terms (Baum & Rowley, 2005; DiMaggio & Powell, 1983; Smircich & Stubbart, 1985). Unfortunately, however, the majority of the work has tended to focus on the impacts that inter-organizational collaboration have on the single organization, reflecting its status as the dominant unit of analysis (Hardy et al., 2003). We know less about the dialectics of (mutual) influence between single organizations or coalitions of organizations and their relevant inter-organizational field (but cf.: Hardy & Phillips, 1998; Miner et al., 1990; Osborn & Hagedoorn, 1997). But we can at least expect this relationship to be dynamic and complex.

In fact, theories of inter-organization collaboration require some sort of theory of social learning to explain the coordination of purpose, values, and activities in addressing a specific problem (cf. Phillips et al., 2000). To this end, theories of “communities of practice,” although traditionally focused on the single organization, can shed some light on the kinds of communicative and other conditions that must be met to realize inter-organizational collaboration (Lave & Wenger, 1991; Wenger, 1998; Wenger & Snyder, 2000). Studies of social capital have, in turn, directed our attention to the way social networks simultaneously facilitate and constrain social action towards a common purpose (Bourdieu, 1977; Castells, 1996; Putnam, 1995; Verma & Shin, 2004).

Recent studies of networked governance suggest that networks are especially well suited to address both technical, strategic (largely “regulative”), and institutional (largely “normative”) uncertainties (Koppenjan & Klijn, 2005). Koppenjan & Klijn (2005) show that networks reduce uncertainties in the three areas by “steering signals” that articulate the core vision and values of the network and by “steering through rules” that regulate membership composition, interaction, (e.g., conflict regulation mechanisms), and outcomes (e.g., product standards and compliance enforcement). Given the socio-technical nature of network governance, extensive and durable weak ties are especially important to the extent that they facilitate better communication and coordination among a diverse array of interests, values, and visions (Clarke, 2005; Molleman & Broekhuis, 2001; Sink, 1991). In this respect, effective reticulists or policy brokers (which could be more than one person) can be critical to overall network performance (Bogason, 2004). Regardless, networks must address the trade-off between flexibility and coherence. With this trade-off comes the need to sustain “creative tension” between competition (or
advocacy) and cooperation (or inquiry). Managing this creative tension is a central requirement of learning organizations and networks (Knight & Pie, 2005; Koppenjan & Klijn, 2005; Senge, 1990; Thompson, 2005). Especially in the context of environmental planning and policymaking, effective networks are characterized by their ability to not only recognize relevant problems but to channel competition between constituent interests to generate ideas and then convene processes for integrating and/or vetting the alternative responses.

Social learning entails both rational (regulative) and normative processes characterized by long periods of incremental adjustment that are punctuated by more fundamental shifts (Baumgartner & Jones, 2002; Healey, 2005; Marcussen & Torfing, 2003). Network management entails “steering through rules” but also occasionally reframing the entire network. On this point, some theorists have drawn attention to the importance of problem frames, especially for environmental conflicts (Gray, 1997; Lewicki et al., 2003). Gray’s (2004) typology of conflict frames is theoretically useful for predicting in general terms the way stakeholders will interact, the likely consequences for the outcomes of planning processes, as well as the likelihood of implementation. But we also need a method for describing the particular form that problem frames assume, depending on the cultural context. To this end, Schön and Rein’s (1994) concept of “cross-frame reflection,” referring to the way policy actors (and theorists!) learn or generate metaphors to move from one frame to another depending on the problem context, is compelling (cf. also Barrett & Cooperrider, 1990; Gold, 2001; Torlak, 2001). But their concept relies heavily on a rational model of learning. In addition, there is a problem with employing a network analytic lens: it tends to “flatten” the view of what are actually recursive processes of communication and control. As a metaphor, “network” is practical to some extent, but it is theoretically limited.

In contrast, theoretical frameworks working in the new institutionalist vein like IAD and ACF suffer from the opposite problem. On the one hand, they achieve a richer integration of rational and normative process models by distinguishing and then linking the various operational, strategic, and constitutional levels of policymaking (cf. Healey, 2005). But while these cognitive model-frameworks are theoretically compelling, their complexity has to date eluded sufficient operationalization for reliable empirical testing and development. In particular, temporal dynamics associated with delays and adjustment times can have surprisingly significant impacts on overall system behavior (Sterman, 2000). Conventional research methods are not up to the task of capturing many of the temporal dynamics implied by cognitive models of institutions.

But there is still a more fundamental methodological problem. Theories of planning, like theories in general, today find themselves in an epistemological crisis at the intersection of science and policy (Ozawa, 1991; Fischer, 2000 and 2003). In a post-empirical world, are there objective criteria for evaluating the “truth” of statements? The way out of the relativist trap is to loosen the requirement of theoretical completeness. Instead, social action and learning depend on making and testing “hunches” (Schön & Rein, 1994). Modelling provides just such an experimental environment to critically reflect-in-action (van den Belt, 2004) and thereby to integrate different forms of expert, lay, factual, and normative knowledge. Of course, it is important to identify the values or assumptions driving the process and to bound the confidence of our claims accordingly (Ozawa, 1991;
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Sterman, 2000). Indeed, studies of modelling demonstrate its potential for facilitating discussions, critical thinking, individual and collective reflection, and learning in a variety of contexts, including planning (Khisty, 1995; Kris, 2003; Meligrana and Andrew, 2003; Ozawa, 1993). Furthermore, computational modelling carries with it the advantage of being able to capture complex dynamics whose nonlinear interdependencies would otherwise elude human intuition (Sterman, 2000; van den Belt, 2004).

To the extent that social practice is communicative, planning theory faces a crisis of legitimacy in practice as well, and nowhere is this more apparent than with the general problem of implementation. Planning theorists have long noted the uneven success of implementing plans, particularly in conflict-ridden contexts (Friedmann, 1969; Pressman & Wildawsky, 1973). They point out that conflicts arise as a result of disagreements not only over goals but over ways to achieve those goals: thus, processes and outcomes cannot and should not be separated. Unfortunately, however, the “implementation problem” reflects a disconnect between planning theory’s traditional focus on technical matters (with its implicit physical determinism) and the social and political realities standing in the way. To address this gap, implementation theorists argue for the need to integrate technical and implementation planning both in theory and in practice (cf. Friedmann, 1993). Above all, plans must be culturally feasible. In a profound sense, planning is as much about building communities of practice as it is about bricks and mortar.

Summarizing, there exists a methodological “gap” between fairly sophisticated social theories of organizational and institutional interactions and operationalized models where specific hypotheses can be made and tested. To the extent that planning is about deliberate intervention of socio-technical systems to bring about some desired future, the field must address this lacuna. First, we need a method to develop middle-range theories of inter-organizational/institutional collaboration. Second, we need a problem-structuring tool that facilitates the joint exploration of the institutional causes and consequences of planning problems. This tool would supplement rather than replace conventional fact-finding methods currently used in planning by broadening the scope of “facts” to include rules of social interaction underlying implementation. Indeed, while an institutional-problem-structuring tool could directly inform institutional designs for implementation, its primary value would be to both generate insights into collaborative capacity (or lack thereof) as well as identify areas needing further inquiry. Furthermore, given the normative nature of planning knowledge, such a method should incorporate a Participatory Action Research Methodology that integrates technical, cognitive, and institutional perspectives (cf. Linstone, 1999) within a learning environment that facilitates individual and collective reflection-in-action.

METHODOLOGICAL FRAMEWORK

In order to address the gap in theoretical and practical understanding of institutional contexts of environmental practices, I propose a Soft System Dynamics Method (SSDM) that focuses on cognitive dimensions of transorganizational dynamics. The components of such a method are already available and merely await assembly. Yet the assembly itself must adhere to some kind of methodology. To this end, I propose to follow the
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Participatory Action Research Methodology (PARM) in general and a Soft System Dynamics Methodology in particular. A brief rationale for using PARM and Soft System Dynamics Methodology will be followed by a description of their application in SSDM.

PARM derives from Action Theory (AT), which has proved especially promising for understanding patterns of social interaction. Building on General Systems Theory, AT asserts that the “purpose” of a given action is only revealed in the effect that the relation between the action and the evoked response has in addressing a given problem. AT takes a systems view that describes “behavior” in terms of the pattern of interaction of parts. AT also emphasizes the importance of implementation since, in this view, a system of interacting parts is only as good as its performance in its relevant task environment. The task environment defines the “goal” or desired behavior pattern (DBP) against which the system’s behavior is measured. The task environment is, in other words, the system’s context of implementation.

AT builds on the recursive paradigm in communication theory to posit a richer understanding of learning (Pearce & Cronen, 1980). In this paradigm, social action (e.g., a planning response) is meaningful to the extent that it fits within a context of interaction that is itself selected for (Luhmann, 1984). Building on Gregory Bateson’s (1958, 1972) pioneering work, Argyris and Schön’s (1978) model of “double loop learning” describes processes in which groups acquire the competency, in the form of a particular feedback loop structure, to respond effectively to problems of a specific type. Working in the same vein, C.W. Churchman (1971) argued for a need to design “inquiring systems” that incorporate an explicit acknowledgement of the value-laden nature of knowledge.

Soft Systems Methodology (SSM) is a form of PARM that starts with the distinction between the “real world problem situation” and systems thinking (or “weltanschauungen”) about the problem situation (Checkland & Scholes, 1990). As an epistemological starting point, the distinction reflects the assumption that all knowledge is fundamentally purposeful, that is: pattern recognition is always governed by some specific search procedure and furthermore this procedure is unexamimable to itself. This fundamental distinction, then, posits a “design view” of socio-technical systems, or, to use SSM terminology, of “Human Activity Systems” (HAS). The design view builds on Action Theory to assert that systems are “doubly problem-driven:” first, a system recognizes problems it can anticipate and therefore address; in this sense communication and cybernetic control are related (Ashby, 1956). Secondly, this problem recognition is itself governed by a deeper purpose that, to the extent the system-as-search-procedure “survives,” addresses a correspondingly deeper problem (Campbell, 1974; Simon, 1996). A design view stresses the importance of the observer who defines or “brings forth” a system as the focus of some kind of intervention (Lendaris, 1986; Maturana & Varela, 1992).

According to SSM, HAS’s are a special case of design systems that carry within them representations of real-world problems – the people comprising these systems have minds of their own quite apart from the outside observer! – and these worldviews are themselves purpose-driven. Thus, HAS’s can be described has having both “descriptive” and “prescriptive” purpose. Descriptive purpose conforms to a recursive logic where value is embedded and cannot therefore be directly measured by the system in question,
whereas prescriptive purpose is objectified (“exteriorized”) by an instrumentalist logic that optimizes value. vi In this respect, anyway, HAS’s are both “soft” and “hard.” Furthermore, SSM’s design view of HAS is systemic, emphasizing the complex interdependence of parts. Thus, SSM is a collective inquiring system (an HAS in its own right) that incorporates both technical and socio-cultural streams of analyses of tasks and issues with an eye toward total system intervention (Checkland & Scholes, 1990; also Armson et al., 2001; Manning & Binzagr, 1996; Steil & Gibbons-Carr, 2005). The strength of SSM is an explicit acknowledgement of the interdependence of inquiry and purpose that facilitates critical reflection on the multiple perspectives that are embedded in, and drive, socio-technical systems. The goal-oriented perspectives are viewed as part of the problem to be modelled.

SSM’s pragmatic value is to provide a root definition grammar to describe and map HAS’s with respect to a given real-world problem situation. The root definition grammar is process-based: various model elements are organized to describe each HAS in terms of solution-oriented transformations. These elements are: “Clients” (the beneficiaries or cost-bearers), “Actors” (those performing the transformations), “Transformations” (the process by which inputs are converted into desiderata), “Worldviews” (used here in the narrower sense of “goals”), “Owners” (the holders of the goals who can stop the transformation), and “Environments” (given constraints).vii Together, these elements are summarized in the mnemonic “CATWOE.” A major advantage of SSM is the discipline which the grammar imposes on problem exploration. By using a mnemonic checklist, participants in an SSM process are encouraged to reflect on the many perspectives of the problem.

Furthermore, SSM brings attention to the problem of implementation: problem exploration usually starts with the (often vague) notion that some worldview – again, treated here in the narrower sense of “goal” – is not being implemented. Therefore, no solution is complete without (descriptions of) processes of monitoring and control. Similarly, planning theorists and practitioners are beginning to inject more accountability into planning by including implementation plans within technical plans. Thus, planning can benefit from SSM’s approach by making the “implementation story” a central concern of the modelling effort.viii Additionally, SSM’s root definition grammar and rich picture techniques facilitate the collective telling of that story by incorporating multiple perspectives on the given problem (Checkland & Scholes, 1990; Gold, 2001; Torlak, 2001).

However, SSM’s solution-orientation ironically results in an overemphasis on prescriptive purpose that fails to conceptualize how diverse purposes can be inscribed into a system of practice (cf. Larsson, 2001). That is, conventional SSM focuses on “tasks” in describing relevant HAS’s while “issues” stemming from differences in worldviews are overlooked. In particular, while SSM’s “stream of logical analysis” is robust, its “stream of cultural analysis” remains methodologically underdeveloped. I argue that this underdevelopment stems from a false theoretical separation of communication and action. A more robust design view more in line with the recursive communication paradigm would assign equal weights to the roles that prescriptive and descriptive purpose play in defining and responding to problems (Larsson, 2001; cf. also: Brocklesby, 2007; Romme, 2003; Vickers, 1965, 1968, 1973; West, 2005). But even if
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we overlook this problem for a moment, the technical promise of conventional SSM to uncover discrepancies between the participants’ mental models and the real world is limited by the bounded rationality of the participants (Rodriguez-Ulluoa & Paucar-Caceres, 2005).

To address some of these shortcomings, Rodriguez-Ulluoa and Paucar-Caceres (2005) propose a Soft System Dynamics Methodology that combines “hard” and “soft” research principles. In particular, they stress the need to make the value-laden aspects of problem scoping and structuring more explicit. To the extent that a problematic pattern of interaction is persistent, we can surmise that the pattern serves some kind of “purpose.” But the evaluation of that purpose – and treating the purpose as a problem that requires an evaluation in the first place – is itself determined by some kind of higher order purpose that must be vetted and arrived at by the stakeholder planning group. That is, problem exploration is first and foremost a search for a shared set of values or common purpose that will serve as an organizing principle for collective action. Only once the stakeholders agree on an organizing principle will they have a framework with which to define the problem and begin to test solutions for both their cultural feasibility and their system desirability. A central outcome of a successful SSM process, then, is a vision statement that articulates the pattern of interaction or DBP that the group desires to achieve. This common purpose subsequently defines the planning problem as a problem of social interaction or coordination and thereby guides the stakeholder group in the modelling and in the eventual policy response.

Having gone through this visioning process, participants in the SSM process can begin to model the problem. First, SSM follows principled negotiation theory in collecting information on stakeholder interests with respect to the planning problem proper and is consistent with SSM’s traditional solution-orientation. This information covers the rational dimension. A key innovation of the method, however, consists of asking stakeholders to 

describe how they interact with one another in pursuit of their interests. This information covers the normative dimension. The two dimensions are then integrated to render the cognitive story of the watershed as a community of practice with greater or lesser collaborative capacity to implement a common purpose. In watershed planning and management, the SSM process should therefore be driven by three basic questions: 1) what values, both in the narrower utilitarian as well as normative sense, does the watershed hold for the various stakeholders and for the community as a whole?, 2) how is the watershed also a community of (mal-) practice?, and 3) what is the relationship between (1) and (2)?

In the language of modelling, the focus of problem definition and intervention defines the domain of model variables which shall be systematically varied and tested. This domain is conventionally called the “model throughput” and falls on the “inside” of the model boundary. “Model throughput” refers to the process by which inputs are transformed into outputs. On the other side of the boundary are the “inputs,” namely, those parameters which are treated as constant throughout the modelling process. Finally, the “outputs” are measures of model behavior or performance. Both problems (inputs) and their responses (outputs) are measured by evaluation criteria derived from the model structure. Thus, I propose that SSM should treat the answers to question (1) as model inputs, while the outputs will be composed of measures of the actual behavior pattern of the watershed
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community as captured in general question (2). The answer to question (3) roughly corresponds to the vision statement or common purpose and provides the criteria by which questions (1) and (2) will be answered. Figure 1 is a schematic of the SSM modelling process:

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Figure 1. Schematic of SSM Modelling Process
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To illustrate, consider a simplified hypothetical example of a North American watershed community composed of farmers, the National Oceanic and Atmospheric Administration (NOAA), and environmental watchdog groups. Each stakeholder group has a distinct set of interests with respect to the biophysical watershed. Assume for a moment that the watershed community currently finds itself embroiled in political strife characterized by lawsuits, distrust, poor compliance of existing regulations, and general ill will among the stakeholder groups. Using SSM, there are two general aspects of the watershed problem to consider: what are the interests among the various stakeholders, and how are those interests playing out as a pattern of interaction among the stakeholders? Using root definition grammar and CATWOE, stakeholders deliberate on both questions.

For example, because one mission of NOAA is to enforce the Endangered Species Act (ESA), one of its primary “inputs,” or interests, would be the health of any endangered species in the watershed. This would comprise NOAA’s “worldview” (or at least part of it), as specified in the “W” in CATWOE. An input such as a ESA listing may trigger an increased oversight by NOAA over farmers, with economic but also social and political implications. That is, the input is relevant to the group in so far as it influences interaction dynamics. These dynamics are uncovered as the participants compare and integrate their CATWOE’s, perhaps with the visual aid of a picture board. For example, depending on the level of compliance (treated here as a model variable that might itself be a function of NOAA budgetary constraints), environmental “watchdog” groups may sue NOAA for failing to adequately enforce the ESA. Lawsuits can have implications for liable parties such as NOAA but also for the trust and goodwill between the parties, with repercussions for future compliance rates, and so on. Table 1 summarizes the component HAS’s of our hypothetical watershed community and their corresponding CATWOE’s.
### Table 1. Component HAS’s of a hypothetical watershed community

<table>
<thead>
<tr>
<th>(Proto-)HAS</th>
<th>Irrigation</th>
<th>ESA</th>
<th>Environmental watchdogging</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Relevant) Clients</td>
<td>Farmers, salmon</td>
<td>Salmon, public, farmers</td>
<td>Salmon, public, NOAA, lawyers</td>
</tr>
<tr>
<td>(Relevant) Actors</td>
<td>Farmers</td>
<td>NOAA, watchdogs</td>
<td>Environmental orgs</td>
</tr>
<tr>
<td>(Relevant) Transformation</td>
<td>Diversion of water for irrigation</td>
<td>Stop illegal withdraw</td>
<td>Improvement of ESA enforcement</td>
</tr>
<tr>
<td>(Relevant) Worldview (prescriptive and descriptive purpose)</td>
<td>Reliable supply of water for irrigation needs where water is a limitless resource and farmers are “free agents”</td>
<td>To keep salmon off ESA list where water is a limited resource and regulatory “sticks” is the central or only strategy that works</td>
<td>To keep salmon populations and their biophysical watersheds healthy where the biophysical environment is limited and should be conserved for its own sake</td>
</tr>
<tr>
<td>(Relevant) Owners</td>
<td>Public, NOAA</td>
<td>Public, NOAA</td>
<td>Environmental orgs</td>
</tr>
<tr>
<td>(Relevant) Environment</td>
<td>Biophysical watershed, irrigation ditches, policy system environment</td>
<td>Biophysical watershed, regulatory instrument (fines), budget, policy system environment</td>
<td>Biophysical watershed, budget, litigation, policy system environment</td>
</tr>
<tr>
<td>Root definition grammar (descriptive purpose not explicitly stated)</td>
<td>A public-owned system overseen by NOAA (Owners) and carried out by farmers (Actors) to divert water from the riverbasin to become irrigation water (Transformation) by digging irrigation ditches (Environment) in order to secure sufficient and reliable water for agriculture (prescriptive Worldview)</td>
<td>A public-owned (Owners) system overseen and managed by NOAA (Owner and Actor) to stop illegal withdraw (Transformation) through fines (Environment) in order to keep salmon off the ESA list (prescriptive Worldview)</td>
<td>A privately-owned and managed (Owners and Actors) system to improve ESA enforcement (Transformation) by suing NOAA if it fails to adequately enforce the ESA (Environment) in order to keep salmon and their biophysical watersheds healthy (prescriptive Worldview)</td>
</tr>
</tbody>
</table>

By enumerating and then connecting HAS’s, it becomes possible to identify important feedback loops and their parameters that influence the behavior pattern of the stakeholder group as a whole. This is done by translating the CATWOE stories into Causal Loop Diagrams (CLD’s) that may elucidate emergent properties. Figure 2 depicts the story linking the three HAS’s (a “+” indicates a positive correlation and a “-“ indicates a negative correlation between the variables).
As behavioral attributes of the group are uncovered, this stimulates the group to deliberate on which attributes are most important to them. The multiple objectives serve as DBP’s against which the actual behavior pattern is compared. Problems will then be defined in terms of the disparity between them. The group may eventually discover, for instance, that lawsuits have a deleterious effect on compliance rates by decreasing trust. Intervention may therefore focus on reducing dependence on lawsuits to improve salmon health. More generally, the group would be able to make their underlying assumptions explicit and furthermore specify the ranges of inputs and conditions which are not covered. Sensitivity analysis would help to identify which areas of model uncertainty are most important and merit further investigation. As this hypothetical scenario illustrates, SSM provides a dynamic framework for a stakeholder group to begin to collectively reflect on and tell the story of their watershed community.

After SSM is implemented, the Soft System Dynamics Method (SSDM) calls for translating “the implementation story” as captured in the CLD into a System Dynamics (SD) model, the second major component of SSDM. SD provides a dynamic and rigorous framework with which to test “hunches” and thus introduces a degree of precision that would otherwise be difficult or impossible to attain (Rodriguez-Ulluoa & Paucar-Caceres, 2005). Forrester (1961) developed SDM from General Systems Theory and the Cybernetics of Communication and Control (Ashby, 1956). SDM starts by conceptualizing a system in terms of “stocks,” which accumulate values (e.g., “x”), and flows which add or subtract values from stocks over time (e.g., “dx/dt”). SDM is based on the notion that complex system behavior is caused by some kind of underlying structure composed of stocks, flows, and feedback loops. These loops interact to generate dynamic behavior. SDM entails the operationalization of causal statements into Ordinary Differential Equations (ODE’s), which can then be computed using mathematical integration (Sterman, 2000). In this way, complex dynamics can be described and explained. And the user-friendly interface encourages experimentation to discover “leverage points,” those relations or parameters that seem to have a significant impact on overall system behavior (Senge, 1990).
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The entire SSDM process is iterative, for the future search conference and subsequent mediated modelling changes the group even as they search for their collective purpose. Thus, some initial inputs or outputs that are identified may be discarded as the problem takes on a new focus. In the end, the inputs, the throughput (the focus of the SSDM intervention), and the outputs all reflect and embody a common set of values of practice, which the group arrives at through the SSDM process. On this point, the unique benefit of SSDM to planning is perhaps most apparent. In conventional planning, plans are “once-off” affairs in the sense that they are never dynamically tested until they are implemented (assuming they are implemented!). They are at that point subject to the inevitable trial-and-error process with its attendant real life costs. In contrast, the SSDM provides an experimental test bed where alternative visions can be compared and tested. It is not only that the “final” institutional design can, in a sense, “anticipate” and thereby avoid many real world lessons. This is, of course, helpful and potentially represents significant cost savings. But perhaps more importantly, the participants in an SSDM process are changed as well and so, to a certain extent, is the real world policy arena about which those lessons are learned. The virtual world of SSDM affords stakeholders the opportunity to discover and articulate the common purpose which is eventually embodied in their design. Thus, when a group of stakeholders learns about the institutional context of the watershed problem, it is, in a profound sense, learning about itself. To that extent, SSDM is a social and policy learning tool for bringing about collaborative capacity. Figure 5 summarizes the SSDM process.

![Flow Diagram of the SSDM Process](image)

**Figure 3. Flow Diagram of the SSDM Process**

DISCUSSION AND CONCLUSION

For several reasons, the marriage of SSM and SD is a natural one. For one, SSM’s root definition grammar can be readily translated, by way of rich picture format and Causal Loop Diagram (CLD) or other means, into the language of Ordinary Differential Equations that drives System Dynamics programs. Furthermore, the user-friendly quality
of SSM’s rich picture approach as well as SD’s stock-and-flow interface is consistent with the participatory action research philosophy. And perhaps most importantly, both SSM and SD utilize the language of feedback loops that focuses on processes and relations and thus facilitates critical reflection about complex interdependencies and levels of analysis. In sum, the language and the user-friendly format combine to produce a simultaneously rigorous, relatively cost-effective, and fun environment for individual and group learning.

In accordance with PARM, SSDM should not be overly theoretical or expert-driven. At the same time, it is entirely consistent with both PARM and Soft System Dynamics Methodology to reserve a place for “theory” in model-building. In particular, SSDM proposes to use the cognitive model of institutions. Beyond this general framework, the paper will briefly discuss several key concepts from institutional theory and theoretical work on inter- and transorganizational dynamics that are amenable to SD operationalization. Building on Wilbur and Harrison’s (1978) work, Michael Radzicki (1988) first proposed the concept of “Institutional Dynamics” that is based on the integration of new institutional economics and SD. The idea is to combine the descriptive richness of institutional economic’s case-study method and the explanatory precision of SD’s “pattern modelling.” Radzicki goes on to note that perhaps the biggest insights into socioeconomic complexity are to be gained not from any particular model but rather from the modelling process itself (Radzicki, 1988).

Radzicki’s work was geared towards theory development. Since then, there have been few attempts to continue his “institutional dynamics” research agenda, although Bardach (1999)’s examination of the developmental dynamics of interagency collaboration extends Radzicki’s analysis to propose an evolutionary “platform model” to explain the emergence of inter-organizational collaborative capacity, or “ICC.” Bardach’s model posits a bottom-up emergence that is perhaps more amenable to an Agent-Based Simulation (ABS) framework than to an SD framework.\textsuperscript{5} But his concepts for “platforms,” ranging (in increasing order of abstraction) from “trust” and “creative opportunity” to “continuous learning,” along with his “momentum processes” (affecting enthusiasm, bandwagon effects, consensus, and trust), “leadership legitimacy,” and “commotion processes” are all compelling and could be operationalized to fit a SD framework. Similarly, Senge’s (1990) “system archetypes,” generic structures that produce recurring types of organizational problems, can and do serve as building blocks for SD modelling.

Sastry (2001) in fact develops an “evolutionary” SD model that combines several loops: a balancing “performance loop,” a reinforcing “competence loop,” to which are attached a reinforcing “inertia loop” and a reinforcing “ability to change” loop. According to Sastry’s model, evolutionary dynamics emerge from the tension between two determinants of performance: competence and “appropriateness” (viz-a-viz the larger institutional task environment). Along similar lines, Repenning (2002) proposes a general model of innovation implementation by connecting a balancing “normative pressure” loop to a reinforcing “commitment-effort-results loop,” to which is attached a reinforcing “diffusion” loop. Repenning observes the same “tipping point” phenomenon, and he identifies a “motivation threshold” that seems to play a critical role in implementing organizational innovation. While these theoretical formulations can inform

\textsuperscript{5}For an overview of PARM, see Wiener and Campbell (1999).
SSDM, to be consistent with the underlying PARM, the specific model structure and parameters will depend on the particular institutional context.

There are to date few applications of SD modelling of organizational dynamics to specific cases. Tucker et al.’s (2005) SD model of a non-profit organization is valuable for demonstrating the significant system impacts that can result from seemingly small parameter changes. Echoing the new institutionalist concept of “punctuated organizational change,” they make the distinction between incremental increases in program support and those actions that trigger a reinforcing feedback process (Tucker et al., 2005, 495). They go on to say that organizations can facilitate double-loop learning if they identify criteria to evaluate decision outcomes before vicious cycles begin (cf. also Garud & Kumaraswamy, 2005). At the same time, they identify the inherent limits of using SD models (or any model for that matter) to evaluate system-wide changes.

Ultimately, SSDM modelling is subject to the real world trial-and-error process. In fact, SSDM can be inserted as a Communication and Information Technology (CIT) technology component into an organization’s knowledge infrastructure to facilitate (trans-)organizational learning.

REFERENCES


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NOTES

i Indeed, the two methodologies share a general form: problem structuring and definition, development of selection criteria, generation of alternatives, testing/selection of alternative, and implementation.

ii Nevertheless, attempts to theorize, let alone model, the dynamic interaction between the ecological and social spheres is still in its infancy (cf. Gunderson & Holling, 2002; Lebel et al., 2006; Walker et al., 2006).

iii The view that is rendered is one of reified nodes and their “links” which are imbued with a physical character, often projected on Cartesian space, while the cultural rules that produce the observed behavior pattern are never adequately examined.

iv Coinciding with, and closely related to, SSM is “Value Systems Design” and “Metasystems Methodology” (cf. Hall, 1989).

v A fuller articulation of this idea can be found in Gödel’s Incompleteness Theorem as well as in the notion of the Turing Machine (cf. also Bateson, 1958: Epilogue).

vi In the language of cybernetics, the distinction between descriptive and prescriptive purpose corresponds roughly to the distinction between “error-controlled” and “cause-controlled” regulation (Asbhy, 1956). Within planning, the distinction between descriptive and prescriptive purpose has informed the long-standing debate between those who argue that planning is (or should be) a rational process (cf. Faludi, 1972) and those who contend that planning is a more incremental and irrational process of “mutual adjustments” (cf. Lindblom, 1959).

vii In SSM, the classes “Clients,” “Actors,” and “Owners” may overlap in their membership.

viii I use the term “implementation stories” to refer to SSM models of problems in order to highlight the notion that problem structuring must consider institutional practices – and the stories they tell! – as part of the problem. The label reminds us of the need to carry out implementation planning in conjunction with, rather than as an afterthought of, technical planning, as is so often the case.

ix Ultimately, of course, the value of SSDM as a social or policy learning tool depends on the extent to which stakeholder representatives truly represent their constituents. A serious question is: to what extent does SSDM merely help to uncover a previously “hidden” common purpose as opposed to truly facilitating creative policy “reframing?” In the former case, SSDM facilitates group learning that reflects on the real world policy arena, almost as a policy analyst might; in the latter, SSDM facilitates a kind of group learning that is less empirically-driven and simultaneously more creative and less reflexive. The greater the initial collaborative capacity of the watershed community, the
more the SSDM process will resemble the former scenario, in which case stakeholder representativeness is more assured. But if there is less agreement on the nature of the problem, and therefore on the need to even convene, the latter scenario is more likely and implementation of any agreement will hinge crucially on whether constituents accept it.

¹ Ann Seror (1994) states that modeling epistemologies are generally one of two types: top-down, or deterministic, and bottom-up, or “emergent.” However, as Seror points out, systems are comprised of both aspects, which suggests that a more integrated modeling approach may be desirable.
E-teaching - Eroding the Stronghold of Teachers

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Abstract

Internet and the World Wide Web have probably caused the most dramatic paradigm changes in learning and teaching, even more than the printed book. The basic objective of teaching is to transform tacit (‘internal’) knowledge of an creator into tacit knowledge of another person, in academia usually by a third person - a Teacher. Therefore communication is of key importance in teaching, both synchronous communication between the Teacher and the Student, and - nowadays equally important - accessing and using stored information (libraries and repositories). Especially in the case of stored information their availability, access, and retrieval are heavily dependent on the available communication technology.

In this paper we consider the evolution of communication technology (section 1) from speech, to handwritten and typeset books, to photocopying and fax, to e-mail, to books produced from camera-ready anuscripts, to the World Wide Web with powerful search engines, to ubiquitous computing, and finally to social computing. We discuss how the essential processes of Dissemination, and Teaching (section 2) and the existing Teaching Types (section 3). In section 4 we discuss basic factors of the teaching process together with their dependence on technological progress. this evolution impacts the knowledge acquisition and dissemination by the Teacher especially in relation to the means of the Student for independent access and acquisition of knowledge. Concentrating on academic institutions we identify three groups of factors of the educational process: Time factors, verification/validation factors and impact factors. The new technologies tend to weaken the position of the teachers versus the students with respect to these factors.

We continue by discussing some emerging effects of the introduction of the new technologies (section 5). foremost questions of verification, validation, lead-time of the teacher and surpsing the teacher. We close with a discussion of consequences for the academic institutions.

Keywords: E-teaching; academic education; evolution of communication technology; World Wide Web; lead-time of the Teacher; evolution verification; authentication; quality assurance

1 Communication in Teaching

1.1 Knowledge Transfer and Communication

The basic objective of teaching is to transform tacit (‘internal’) knowledge of an Originator into tacit knowledge of another person. In our simplified model of knowledge dissemination we use three prototypical roles (fig. 1):

the Originator : The person who created some knowledge which is valuable and is considered to become a part of the scientific knowledge base.

the Teacher : The person who acquires this scientific knowledge in order to pass it along to the Student. It should be noted, that in other circumstances he/she also appear in the role of a Student.

the Student : The person trying to absorb the scientific knowledge available.

Classically (following the SECI-model of [Nonaka-95]) teaching is achieved by first transforming the tacit knowledge into explicit knowledge, which then can be transmitted to another person. Due to division of work and specialization (one of the basic steps towards civilization) the transfer of knowledge is usually taken care of by specialists (the ‘Teachers’). Especially in academic institutions (typically universities) the teaching process usually is closely connected to research: for example Austrian universities are by law obliged to perform ‘research guided’ teaching. This means that Teachers is not only transmitters of knowledge but also Originators. Communication of knowledge is a key in this process (fig. 1). On the other hand the Teacher will not create all the knowledge
by himself/herself: accumulation of knowledge is a generation-long, multi-person undertaking where the Teacher himself also acts as a Student in other situations (fig. 1).
Many Originators themselves have long passed away. In this case the Teacher has to rely on ‘second hand’ knowledge which has been preserved (and perhaps even distorted).
In the sequel we will analyse the various processes and how they have changed over time and with technology.

Fig. 1: The basic teaching process

1.2 Relevant Advances in Communication Technologies

Communication is the key to successful knowledge acquisition and dissemination. Historically ICT has provided a multitude of dramatically new communication methods which also impact teaching. Fig. 2 shows key steps of the evolution of communication technology in roughly chronological order. The columns have the following meaning:

- **technology**: major steps of technology achievement. In [Chroust-03b] a lengthy discussion of the individual technologies and their essence appears. Here we have added a new, upcoming one, *social computing*. Today’s speed, ease-of-use and ubiquity of the internet makes it feasible and useful to utilize the internet as a basis for community based work. Like in the real world where we ask somebody, we seek and get advice, recommendations and help via the internet, even from total strangers.

- **new achievement**: major new qualities of the new technology. We have selected only those qualities which we believe are relevant for communicating knowledge from one generation to the next [Chroust-98f] [Chroust-99i] [Chroust-99b] [Kraut-94], see below for details.

- **document production and access effort**: What is the effort (time/cost) to produce a document? What does it take to gain access to the document?

- **persistence of document**: How persistent is the contents of the document, can it be easily changed, are changes noticeable?

- **immediate effect**: some of the effects on the users (especially in the context of e-teaching) are mentioned.

In column 2 of Fig. 2 we have identified a major achievement of each respective technology:

- **abstraction**: Without abstraction we would never be able to speak about the future, about concepts, about fiction etc. We would be limited to physically observable facts and would have difficulties in communicating them to others, especially over time.

- **persistence**: Only by committing markings to some persistent medium for recording data it has been possible to transport information over time and space [Chiera-68, Doblhofer-90, Noveck-75]. Initially only the persistence in time could be achieved, since the value (and sometimes also volume) of these documents posed economic and/or practical limits to transportability.

- **volume reproducibility**: Printing has allowed, in contrast to hand writing, a practically unlimited production of copies and has thus permitted the sharing of information with many.
<table>
<thead>
<tr>
<th>Technology</th>
<th>new achievement</th>
<th>document production (&quot;P:&quot;), and access effort (&quot;A:&quot;), persistence of document, immediate effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech</td>
<td>abstraction</td>
<td>P: n.a., A:n.a none, transformation of tacit into explicit knowledge</td>
</tr>
<tr>
<td>Handwritten texts</td>
<td>persistence</td>
<td>P: usually not very high (depending on material), A: high, preservation of original texts</td>
</tr>
<tr>
<td>Typeset Printed Books</td>
<td>volume reproducibility</td>
<td>P: very high, A: medium (book shop) very long, ability to disseminate, bringing knowledge to people (push instead of pull)</td>
</tr>
<tr>
<td>photocopy/fax</td>
<td>individual instant reproducibility, fast interchange of text/graphic material</td>
<td>P: easy, fast, A: (as receiver) very small high, like paper transmission and dissemination of individual material without need for a publisher/printer</td>
</tr>
<tr>
<td>E-mail</td>
<td>fast interchange of machine readable material</td>
<td>P: minimal, A: minimal very high, when stored speed of transmission, material can be immediately excerpted and worked on, seamlessness, push technology with respect to communication</td>
</tr>
<tr>
<td>books with camera-ready supplied material</td>
<td>individual production of papers in high quality, cheaper book production</td>
<td>P: low to medium for book producer (effort carried by submitters) A: book market and electronic offerings high, when printed, low when on electronic media, unnoticeable changes reducing the time to publish, reducing cost</td>
</tr>
<tr>
<td>World Wide Web / search engines</td>
<td>cooperation, pull technology</td>
<td>P: very low, A: very low very low ability of find from the computer all which is 'known' in no time. 'pull technology' with respect to communication</td>
</tr>
<tr>
<td>Ubiquitous Computing</td>
<td>immediate availability of access</td>
<td>P: depends on document, A: makes access easier n.a. the advantages of ICT become mobile, can be used anytime, anyplace</td>
</tr>
<tr>
<td>Social Computing</td>
<td>cooperative advice and guidance by peers</td>
<td>P: like e-mail., A: like email or easier none, if not stored permanently being able access the 'whole' community ad libidum , help to filter the enormous flood of information</td>
</tr>
</tbody>
</table>

Fig. 2: Communication Paradigms

**instant individual reproducibility**: Printed books allowed the distribution of knowledge to many. For cost effectiveness rather large quantities had to be produced by a lengthy process. Photocopying (e.g. xerography, nowadays also digital scanning) allows to produce a small amount of copies quickly at a reasonable price and in high quality.

**fast interchange of machine readable material**: E-mail has permitted the transport of machine readable information over long distances in practically zero time. Moreover the sent document could immediately be processed, modified, augmented etc. This is a property not shared by letters or fax. E-mail pushes the information on the recipient (in the negative case also spam!)

**individual production of high quality papers**: Desktop Publishing allows the production of aesthetically pleasing documents which have the same appearance as type-set publications. This is also the basis for producing camera-ready books. This reduces the 'Time-to-availability' to a small fraction of time as compared to type setting.

**cooperation, pull technology**: World Wide Web (WWW) has allowed world wide cooperative exchange of information thanks to powerful search engines. Easy retrieval of facts has become possible. Information is pulled from the WWW; potential users do not have to wait until information has been pushed towards them.

**immediate availability of access**: Immediate access to practically any information irrespective of location is a supportive technology, making some of the other technologies highly useful. The Library of Congress and all data of the Bureau of Census etc. in their most up-to-date form are available on the mobile phone or on some wearable computer outfit [Hoffnagle-99, Cole-97].
cooperative advice and guidance by peers: It is easy and fast to ask one’s peers to get information presumed to be valuable. In their daily life humans have always sought advice from experts or peers. Systems were build to support people in their job performance via so-called Electronic Performance Support Systems (EPSS, [Banerji-95, Chroust-00e, Burgess-00, Racine-04]. Today’s system allow to observe user behavior and based on the behavior of peers, these systems advise other users with respect to their actions or decisions (‘recom-
mender systems’ [Balabanovic-97, Gams-02, Mertens-97, Pu-06, Resnik-97]. Obviously these possibilities offer a Pandora’s box!

2 The Knowledge Dissemination Process

2.1 The subprocesses of dissemination

To understand the changes technology has affected for e-Teaching and the position of the Teacher the whole knowledge dissemination process must be considered from its very beginning. Based on [Chroust-05v, Fig. 3] we can describe the process like in fig. 3. The details of fig. 3 will be discussed below.

![Fig. 3: Basic Delays in Academic Education](image)

We can distinguish the following key activities (subprocesses), some of them have further subprocesses, see fig. 4.

Creating Knowledge: generating new knowledge based on existing knowledge. We can split this process into several complimentary processes:

- **searching**: identifying information, finding it somewhere, collecting it, and actually accessing the contents
- **authenticating/validating**: once a document is identified the question is whether it is a true representation of what it pretends to be. If this is true, then its validity has to be established, to a large extend by comparing with other documentation (which also might have to be searched.
- **digesting**: working with the material, understanding it, prepare it for presentations etc. This may give raise to looking for more (refining) which might lead to another search etc.
- **filtering**: especially for teaching the Student a careful selection of material is needed
- **presenting**: finally the newly created knowledge has to be brought into a form amenable to present to others (book, paper, speech, ..) this might include presentations to a conference.

Publication: in the wider sense, i.e. making it available to a larger public. Traditionally because of the considerable investments (copying, type setting, printing etc.) some evaluation had to take place before actually starting the production. We see two essential subprocesses
authenticating and validating: the proposed text to be disseminated. Publishers want to make sure that the author(s) are not faked and that the material stands up in comparison to other material. To this effect, editorial boards, programme committees etc. are institutionalized.

production: of the actual artefact to be distributed,

Teaching: i.e. trying to collect, organize, existing knowledge and preparing it for presentation to the Student. The same subprocesses can be distinguished (with minor semantic differences): searching, authenticating and validating, digesting, filtering, presenting.

Fig. 4: Subprocesses of Knowledge Generation and Teaching

2.2 The Student’s Learning Process

In order to understand the changing relations between Teacher and Student we also have to sketch the essential processes of learning also with the eyes of the Student.

Fig. 5: The Student’s Learning Process

The five important processes are discussed below. They differ from section 2.1 only in minor ways.
**digesting**: receiving the information from the teacher, classically in the form of a

**rechecking**: During digesting the Student might want to check back whether the citation, explanations etc. were correct, checking the sources used/given by the Teacher. In many cases this would additionally cause some searching for additional material (‘refining’) the presented material, preferable from the original material sources given by the Teacher.

**searching**: same as in section 2.1

**authenticating and validating**: same as in section 2.1

Fig. 5 shows a second trigger besides the teaching of a Teacher. A serendipity way of searching available sources for interesting relevant material, often not related to the topic of teaching. Nevertheless this searching might also provide useful material (e.g., unexpectedly finding an old mathematics book from one’s grandfather).

### 3 Basic Types of Teaching Processes

Ignoring some details we can today identify four types of Teaching Environments which emerged in parallel and were supported and enabled by the advances in ICT [Kraut-94]. Technology provided both communication and storage means.

#### 3.1 Speech-based Teaching

Before the invention of writing [Chiera-68] the prototypical teaching process looked as in Fig. 1. The knowledge dissemination process was purely face-to-face. The memory of persons was the only repository for previous knowledge.

#### 3.2 Single-copy based Teaching

The utilization of writing, once it achieved a sufficient ability to express concepts and complex notions [Caubet-01, Chiera-68], brought about a considerable paradigm change [Chroust-98f]: the personal link between Originator and Teacher lost its key importance (Fig. 7). This personal link was paralleled or even replaced by stored documents. This established a certain persistence of the Originator’s work. Recording used all kinds of media, clay tablets fig. 6, parchment, paper; etc.

Without a direct link to the Originator, the Teacher has to rely on written material on an intermediate storage medium to acquire the knowledge for presentation to the Student. A body of knowledge accumulated. The libraries and archives of monasteries were key centers of scientific research and documentation. Authenticity could be established even if the Originator was not accessible or dead. The transmission from the Teacher to the Student was and still is largely face-to-face (Fig. 7).

![Fig. 6: Mesopotamian Clay Tablet](attachment:image.png)

The access to these usual single copies was obviously difficult and involved effort and even dangers (travel!).
3.3 Printed-book based Teaching

Printing technology permitted large volume documents and books to be produced in quantities, especially since a large portion of the cost was fixed cost, independent of the number of copies. Off-prints came rather cheap. The value and the size allowed to transport/send books and sell them in different places. At this point the Student could - and eventually did - acquire books themselves, be it by buying or by borrowing from the university libraries (fig. 8). Suddenly there was a real chance to verify the teachings of a Teacher.

Especially with the new combined technology of desk-top publishing and photomechanical reproduction the price for book production dropped and a new type of books appeared: text books, specifically tailored for supporting studying (both for the students and the teachers). Teachers got considerable material pre-fabricated, ready to use. The book industry flourished. In parallel not only books but also scientific journals were growing.

Desk top publishing and assembling books from camera-ready submitted material did not basically change the paradigm, but generated, due to the reduced costs, a flood of new books on the market, especially once the printers were able to directly process material without the detour via printed paper. Especially with printing etc. also another problem arose: more and more researcher wrote about the original material, refining it, discussing it, providing "second sources".
3.4 The World Wide Web based Teaching

The World Wide Web has brought about a new phenomenon (fig. 9): everybody can put material on the Web and - due to search engines - also has a good chance that the material is seen/read by a world-wide public. Publication and dissemination are no any more channeled and thus controlled by publishing houses. Looking back into history, in 1517 Martin Luther’s way to publish outside the established (church) channels was to nail a document to a church door of a small village. Many of its inhabitants were probably unable to read!

Nowadays the World Wide Web is bidirectional: everybody can read everybody else’s posting (at least theoretically). The Web is becoming an enormously large document repository. Memorizing facts looses some of its importance in favor of just-in-time access to the internet.

![Fig. 9: The influence of the World Wide Web](image)

3.5 The social computing based Teaching

Social computing, utilizing what also is called Web 2.0 [Wikipedia-e, ⇒ Web 2.0], i.e. the technologically supported communication anywhere, anytime, allows users to get quick reactions to questions asked by to other users. The Web binds persons into a network. The Web is able to pro-actively offer services like making personalized suggestions about interesting books or restaurants nearby, so-called ‘recommender system’ [Balabanovic-97]). Soon this will be also modify the teaching process.

![Fig. 10: The Web 2.0 society](image)
A danger is that people will not bother to memorize or learn anything, they will rely more and more on just-in-time advice from just anyone - reliable and knowledgable or not. It seems to be less cumbersome to ask somebody and to get a quick answer than bothering oneself to recherche facts. The effects and the impacts are not really clear yet. The individuals and the society have still to learn this new medium, to understand the potential and the dangers. To some extent we revert from a reading society to a verbally and iconic oriented ‘question asking’ society (fig. 10).

4 Essential factors in the Teaching Process

Based on the description of the subprocesses above (section 2.1) and the various technologies we can identify certain key factors and discuss their change due to the different technologies [Chroust-05v]:

Time Factors:

The delays needed for various activities have been dramatically reduces by the new technologies. Especially transmission of information has been reduced to practically zero delay. Some key timings in the teaching process are shown in fig. 3:

**Time-to-Emergence**: How long does it take from the start of the knowledge creation (vague as this notion is) until the work is finished and ready to be made public?

**Time-to-availability**: How long does it take until the knowledge is brought into some material form to be made available to a (even limited) public?

**Time-to-Teachability**: When is the knowledge in a form ready to be taught to the Student (or attendees of a seminar)?

**Time-to-Delivery**: When is the knowledge eventually actually thought to the students?

<table>
<thead>
<tr>
<th>Time-to-xx</th>
<th>actor</th>
<th>Single-copy based</th>
<th>printed book based</th>
<th>World-wide Web / email</th>
<th>social computing based</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-to-emergence</td>
<td>Teacher</td>
<td>very long</td>
<td>very long</td>
<td>long</td>
<td>long</td>
</tr>
<tr>
<td>comment</td>
<td>Faster production due to better communication (author - reviewers)</td>
<td>Faster communication (e-mail), better communication between stakeholders</td>
<td>Faster community reaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-to-emergence</td>
<td>Student</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>comment</td>
<td>not a student activity</td>
<td>not a student activity</td>
<td>not a student activity</td>
<td>not a student activity</td>
<td></td>
</tr>
<tr>
<td>T-to-availability</td>
<td>Teacher</td>
<td>very long</td>
<td>long</td>
<td>same as T-emerg</td>
<td>same as T-emerg</td>
</tr>
<tr>
<td>comment</td>
<td>long production</td>
<td>Faster production and distribution</td>
<td>reduction due to faster communication of reviewers</td>
<td>still faster due to increased peer-interaction</td>
<td></td>
</tr>
<tr>
<td>T-to-availability</td>
<td>Student</td>
<td>∞</td>
<td>long</td>
<td>same as T-emerg</td>
<td>same as T-emerg</td>
</tr>
<tr>
<td>comment</td>
<td>not feasible</td>
<td>long, but can be done via library search</td>
<td>no entry control</td>
<td>no entry control</td>
<td></td>
</tr>
<tr>
<td>T-to-delivery</td>
<td>Teacher</td>
<td>long</td>
<td>long</td>
<td>T-emerg</td>
<td>T-emerg</td>
</tr>
<tr>
<td>T-to-challenge</td>
<td>Student</td>
<td>∞</td>
<td>long</td>
<td>short</td>
<td>very short</td>
</tr>
<tr>
<td>comment</td>
<td>not accessible</td>
<td>cost, ordering</td>
<td>search via internet</td>
<td>even shorter (asking peers)</td>
<td></td>
</tr>
<tr>
<td>T-to-surprise</td>
<td>Student</td>
<td>∞</td>
<td>unlikely</td>
<td>faster than Teacher!</td>
<td>faster than Teacher!</td>
</tr>
<tr>
<td>comment</td>
<td>not accessible</td>
<td>cost, ordering</td>
<td>immediate accessibility</td>
<td>even shorter (asking peers)</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 11: Technology’s influence on Timing

Verification/Validation Factors:

Knowledge passed on in a teaching process need not be correct. We distinguish verification (How can one assure that the knowledge one receives is a true replica of what was created?).

The scientific paradigm implies that the process of creation of knowledge is as [Haux-98, p.9] formulates (translated) *a methodical process systematically performed, with inter-subjectively retraceable, goal-oriented research and knowledge creation.*
To consider verification by the Student it is necessary to understand the effort needed to verify the correctness of a claim made by the Teacher. The Student would like to check against the original document as produced by the Originator ("re-tracing"). One has to take into account whether there is a feasible and realistic chance to access the original document, considering both the time effort and the financial expenses. Cost and effort depend to a large extend on the applicable technology.

A second issue is validation. Validation means checking whether the knowledge is correct, i.e. that is a correct interpretation of facts or compatible with other knowledge. Here the correctness of the offered knowledge has to be compared with and measured against existing other knowledge, facts, etc. Key factors supporting verification and validation are:

**persistence**: Can the knowledge change/be changed without any indication. Will it be in its place in the future?

**traceability/verifyability**: Having a copy of the knowledge, can one trace it back to its roots? Can one establish that the knowledge was transferred unaltered?. What is the effort to do so?

**domain accessibility**: How easy is it to find similar, supporting, contradicting material in the domain of discourse, often called the ’Body of Knowledge’ [ISO19759-01, PMI-05] e.g. alternate, competing information and paradigms (which often are suppressed or stifled, see [Kuhn-70]).

<table>
<thead>
<tr>
<th>Factor</th>
<th>actor</th>
<th>Single-copy based</th>
<th>printed book based</th>
<th>World-wide Web / email</th>
<th>social computing based</th>
</tr>
</thead>
<tbody>
<tr>
<td>persistence</td>
<td>Teacher</td>
<td>long-lived</td>
<td>longlived,</td>
<td>unsure</td>
<td>unsure</td>
</tr>
<tr>
<td>comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td>inaccessible</td>
<td>longlived, archived</td>
<td>vague</td>
<td>vague</td>
</tr>
<tr>
<td>traceability/verifyability</td>
<td>Teacher</td>
<td>difficult</td>
<td>good</td>
<td>fast, but unreliable</td>
<td>fast, but unreliable,</td>
</tr>
<tr>
<td>comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td>impossible</td>
<td>possible</td>
<td>fast, but unreliable</td>
<td>fast, but unreliable,</td>
</tr>
<tr>
<td>validation</td>
<td>Teacher</td>
<td>very difficult</td>
<td>easy (book shops and libraries)</td>
<td>very easy and fast</td>
<td>very easy and fast</td>
</tr>
<tr>
<td>comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td>impossible</td>
<td>easy (book shops and libraries)</td>
<td>very easy and fast</td>
<td>very easy and fast</td>
</tr>
<tr>
<td>alternate paradigm knowledge</td>
<td>Teacher</td>
<td>very difficult</td>
<td>difficult</td>
<td>very easy, but flooding</td>
<td>very easy, but flooding</td>
</tr>
<tr>
<td>comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>alternate paradigm knowledge</td>
<td>Student</td>
<td>impossible</td>
<td>difficult</td>
<td>very easy, but flooding</td>
<td>very easy, but flooding</td>
</tr>
</tbody>
</table>

*Fig. 12: Technology’s influence on Verification and Validation*
Impact Factors: How many Students can a Teacher reach with his/her knowledge. What is the area which can be reached by a Teacher to collect material and existing knowledge?

aura of the Teacher: The aura [Chroust-03a] can be understood as the "totality of all influences and effects around a person" [Kotzian-98] or the "subspace which limits the effective presence of an object in a given medium" [Gross-97, p.98ff]. How many addressees can be reached? How far is the influence of the Teacher felt?

source domain: How large is the area/domain from which information and knowledge can meaningful be consumed. This is, so to speak, the counterpart to the aura. It is the domain from which a researcher or teacher draws information in order to compare and validate his knowledge.

<table>
<thead>
<tr>
<th>factor</th>
<th>actor</th>
<th>Single-copy based</th>
<th>printed book based</th>
<th>World-wide Web / email</th>
<th>social computing based</th>
</tr>
</thead>
<tbody>
<tr>
<td>aura</td>
<td>Teacher</td>
<td>small</td>
<td>larger</td>
<td>world wide</td>
<td>world wide</td>
</tr>
<tr>
<td>comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>source domain</td>
<td>Teacher</td>
<td>small</td>
<td>larger</td>
<td>world wide</td>
<td>world wide</td>
</tr>
<tr>
<td>comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>source domaine</td>
<td>Student</td>
<td>null</td>
<td>larger</td>
<td>world wide</td>
<td>world wide</td>
</tr>
<tr>
<td>comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 13: Technology’s influence on Impact Factors

5 Emergent Effects - eroding the Stronghold of the Teacher

The indicated technology changes have far reaching consequences on society - far more than can be discussed here. We will concentrate on the position of teachers, especially in relation to the students.

5.1 Multiplication of stakeholders

We have to recognize that with World WideWeb the players in this ‘dissemination game’ got multiplied. New technologies allow a much more details and wider search, but also more researchers are at work. This means that despite of the increased speed of search machines etc. the inspection and analysis of the material needs more effort.

Fig. 14: Overview of e-teaching
5.2 Verification/Validation by Students

As long as a Teacher teaches following a textbook (often his own!) there is little danger that the Student will detect major discrepancies - except for typos or slips of the tongue. Looking into other textbooks did not occur to a larger extent.

Nowadays it is easy to consult the World Wide Web (e.g. Wikipedia [Wikipedia-e]). Thus it is easy to find alternate sources for the same material - often unknown to the teacher - which might give different definitions, interpretations, etc.

5.3 Lost Lead-time of the Teacher

Dissemination of knowledge needs a certain lead-time for the Teacher to fulfil the subprocesses shown in fig. 4. He/she has to acquire information, analyze, comprehend ('digest') the material, and finally prepare teaching material. Only then the Teacher would be ready to lecture about this subject ('Time-to-Teaching'). In the classical university it will then take some time until the material is actually presented to the Student (waiting for the next term or announcement of a course, etc., giving the Teacher perhaps some additional breathing time.

Under the classical technologies the Student were unlikely or even incapable of getting the material before the Teacher had presented it. We call this the Teacher's "lead-time". It is the time the Teacher is able to acquire the knowledge earlier than the Student. The lead-time is - so to speak - the safeguard against surprises. The value of lead-time could easily become negative, indicating that the Student is 'faster' than the Teacher and thus is able to 'surprise' the Teacher.

5.4 Informal Channels

In a scientific community the key actors usually know one another. This also means, that they know what their colleagues are working at, what knowledge they are just trying to create. Thus even if a Student detects a 'new' document on the internet, just from the author and/or the title another colleague can make an educated guess what is written in there.

These informal channels are established through conferences, meetings and sometimes by explicit information interchange. The speed up by e-mail/internet has considerably reduced the Time-to-delivery (cf. fig. 3) and thus has reduced the chance for an 'unintended', informal information exchange.

5.5 Alternative Ideas / Challenging the Teacher

Only with the World Wide Web unorthodox ideas have a good change to be distributed. Being caught in one's own paradigm (cf. [Kuhn-70]) a Teacher might not realize an idea or ignore it until a Student confronts him/her with it. Chances are good that the Teacher is completely surprised by this.

5.6 No-name papers / Surprising the Teacher

An interesting question is how easily a Student can surprise the Teacher with new knowledge acquired somewhere else?

The Student might by chance (serendipity!) come across some knowledge and present it to the Teacher, perhaps in order to impress or embarrass the Teacher. The concrete document (e.g. a paper or even a book) might be unknown to the Teacher. Usually we expect that the Teacher is aware of his/her field of expertise. How much surprise does the newly shown document hold for him?

6 Summary

The considerations above have considerable consequence on the Teaching paradigm of our days:

- **Reduced value of stored knowledge**: The value of accumulating information will diminish in favor of a just-in-time hunt for the latest information on a given topic [Schneider-96]. This allows to abolish most of the contents of 'shadow copies' in one's file cabinet, in the internet one finds these articles faster and more reliably.
Loss of stability and persistence of documentation: We have to live with the fact that the information which we acquire from the Web will be unstable, volatile and often changed. Ways to ensure the permanence and authenticity of results once published have to be designed.

Lost quality control: Currently the Internet has a problem with quality assurance due to the possibility of direct, unconstrained publishing. At the same time the filtering mechanism which helped the Teacher to distinguish 'valid' from 'invalid' knowledge via publishers and selected peers (with all the uncertainty connected with validity in science) seems to be lost.

Lost lead time/surprise: Although all previous changes in technology reduced the critical time delays, only with Internet and World Wide Web the Students came into a situation where they could easily overtake the Teacher with respect to acquisition of new information (perhaps even knowledge) depriving the Teacher of his lead-time. The Student presenting to the Teacher a text freshly loaded down from the Internet might surprise the Teacher.

Improving verification/validation need: New verification and quality assurance is needed. Verification and quality assurance (previously done by publishers and programme committees) must be (re-)introduced in an appropriate way in order to eliminate the uncertainty for pseudo-knowledge on the Internet.

Student emancipation: The university system will have to change [Chroust-98f] [Chroust-99b] by helping the student to do more research on their own and helping them to distinguish the quality of documents found on the Internet ("trash-filter").

Changed role of the Teacher: The role and the self-understanding of the Teacher will change. He/she cannot anymore rely on a large lead-time and believe to be immune against outsiders with good ideas. The Teacher will become more an advisor/moderator and interpreter than the owner of knowledge and less of 'lecturers'. And they have to accept the sudden appearance of hitherto unknown information.

Summing up we see that the change in technology (especially World Wide Web) together with ubiquitous computing have caused tremendous changes in the scientific domain. And this strongly affects the relation between students and Teachers, call for a new role understanding of Teachers.

Literatur


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DIALOGUE AND ECOLOGICAL ENGINEERING IN SOCIAL SYSTEMS DESIGN

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ABSTRACT

A number of systems theorists and practitioners have described ways in which human systems of thought and interaction might be consciously designed. Banathy (1996) specifically proposed approaches to the design of human social systems through conversation and dialogue. More recently, Allen, et al., (2003) have proposed distinctions between environmental engineering and ecological engineering, which offer valuable insights into some of the difficulties inherent in the design of human systems. This paper will explore ways in which engineering, as applied to ecological systems, may help us better understand design as applied to social systems.

Keywords: dialogue, organizations, social systems, eco-systems, ecological engineering

INTRODUCTION

The ways in which we envision or understand systems determine much about the ways in which we attempt to affect them. The industrial era created a concept of organizations which mirrored the machines on which it was built. An efficient organization was to run like “a well-oiled machine.” A clear division of labor improved efficiency and productivity. Frederick Taylor’s program of Scientific Management further optimized each task through isolation and measurement. In work with human organizations and institutions, it appeared that this debate might have been resolved with the shift from a mechanistic to an organismic metaphor view. In reality it only seems to have created additional confusion. Very few professionals would argue today that human organizations could be viewed simply as machines. In practice, though, many still rely on approaches based in this underlying assumption. In broader terms, it remains as the split between “hard” and “soft” approaches.

Early systems approaches relied on a mechanistic conception of organizations and institutions. Operations research, for instance, used highly successful solutions to mechanical and logistical problems in addressing institutional and organizational issues, first in the military during World War II, and later in industrial production.

Theorists and practitioners from many fields, of course, ranging from philosophers to organizational researchers challenged this mechanistic view of people and organizations. Schools of thought, from Marxism to humanism, challenged the ability of the natural sciences, based primarily on physics, to capture unique aspects of humanity.

Some systems-oriented approaches still argue for the need for quantitative research and modeling. According to the Web site for the Operations Research Center at the Massachusetts Institute of Technology, “Operations Research (O.R.) is the discipline of applying advanced analytical methods to help make better decisions” (http://www.mit.edu/~orc/). Current applications of OR include economics, marketing,
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manufacturing, transportation and medicine. A very similar approach can be found in more traditional approaches to System Dynamics, which relies on mathematical modeling and computer simulation of feedback loops to describe system functioning. First applied to business organizations, the principles were then expanded to urban planning and global environmental modeling.

Ackoff, Banathy, Checkland, Churchman, and others (Banathy, 1996) challenged the application of such engineering-oriented approaches to human systems, arguing that social systems could not be treated effectively as mechanical systems. Critical Systems theorists challenged issues of power disparity in human systems even further. Other approaches such as Interactive Management and the Cogniscope might be seen as a middle ground, including the involvement of stakeholders into design, but into a process captured through computer modeling. Later variations of earlier methods, including second-order cybernetics and Viable Systems Modeling, as well as “softer” approaches to System Dynamics, attempted to capture more human aspects of systems as well.

This debate within systems sciences only reflects the divisions in much larger realms. Some scientists and researchers still believe that measurement and mathematical modeling are the only ways to achieve any sense of accuracy – especially when attempting to predict future events or behavior. Others, more typically in the humanities or social sciences, argue that these approaches are simply not adequate to deal with the complexity of human systems.

While on the one hand espousing the value of people to organizations, and emphasizing the critical need for initiative, leadership, innovation and a host of other human characteristics, decision-makers at many levels continue to operate in mechanistic ways. Organizations value creativity and innovation until a downturn occurs, at which point only efficiency, productivity and return on investment seem to matter (significantly reducing the capacity for creativity and innovation.) These same business principles have been applied to the US Federal agencies, and to educational institutions through initiatives such as No Child Left Behind (for primary and secondary schools) and through requirements for outcomes-based measurements at university levels.

As systems scientists, we have argued for an understanding of principles such as emergence (that new properties come to light at new levels of organization.) We do not expect the properties of cells to express the full functioning of organs or organisms. And yet we continue to deal with human societies through sciences developed for physics, or possibly biology at best. By way of comparison, Allen, et al., (2003) have proposed distinctions within biological systems that may be of help in at least clarifying some of the problems that we have as we move towards a fuller understanding of human social systems.

ENVIRONMENTAL AND ECOLOGICAL ENGINEERING

Allen, et al., (2003) have drawn a distinction between environmental engineering and ecological engineering. Environmental engineering, as they describe it, is essentially the use of biological material as machines, or incorporated into machines. (Note the similarity with the concept of mechanistic human organizations.) This includes everything from horse-drawn farm equipment to the use of yeast in making cheese or beer, to much more complex genetic engineering.

Environmental engineering is a branch of civil and sometimes industrial engineering. As such it remains within the purview of standard engineering protocol as it imposes an external design on material that is the passive recipient of engineered limits. Not so for
ecological engineers, whose engineered material offers no such constancy (Allen, et al., 2003, p. 391).

Ecological engineering, on the other hand, does not deal with controlled environments and has to contend with the unpredictability of ongoing interactions and evolutions. As they explain the difference:

The theory to which we refer introduces a clear distinction between: (i) a process of design and fabrication of machines driven by human purpose, i.e. environmental engineering as described above and (ii) the processes of autopoiesis (self-definition) and self-organization (emergence or order) typical of life and ecological systems (Maturana and Varela, 1980, 1998) i.e. ecological engineering (Allen, et al., 2003, p. 390).

In teaching entrepreneurs how to establish a new business, the most common process involves the production of a business plan. In most cases this only reaches the level of what is (hoped) to be done, with very little focus on how it is to be achieved. As we continue to track the distinctions made by Allen, et al. (2003), it becomes clear how our usual processes of planning mimic more mechanical approaches to engineering.

An abstract description of engineering starts by recognizing the existence of a given set of goals at the outset. Often the goal can be a general statement coming from a client at some level. Engineers commonly require those goals to be explicit and settled before the actual engineering starts… The real engineering does not start until the planners have made their final decisions (p. 394).

In most cases we could substitute “strategic planner” or “business analyst” for “engineer” with the same accuracy, as in “An abstract description of strategic planning starts by…” Much the same could be said of urban planning, many styles of negotiation, and even family therapy – especially the more behaviorally oriented approaches.

Not only do explicit goals fix the intended outcome, they also effectively create a closed system in which the design and implementation are to take place. They assume a high degree of stability in the environment, without which no plan can be expected to create a predictable outcome.

The closure of the information space arises through the imposition of two sets of constraints: (a) those reflecting the decisions made by the planners and the characteristics of the associative context (this is what drives the selection of a type); (b) those imposed by technical and economic aspects of the processes of realization (this is what presses the argument for a particular process of fabrication reflecting the selected type) (Allen, et al., 2003, p. 395).

**Autopoietic Systems**

What would it mean to approach human social systems design from the perspective of ecological engineering? We should first revisit an earlier distinction made by Allen, et al. (2003) between environmental and ecological engineering. While environmental engineering “imposes an external design on material that is the passive recipient of engineered limits,” ecological engineering understands that the materials with which it works have no such constancy (p. 391). Allen, et al. also refer to ecological systems as autopoietic systems, in much the same way that Luhmann (1995) referred to social systems.

The theory of self-producing, autopoietic systems can be transferred to the domain of action systems only if one begins with the fact that the elements composing the
system have no duration, and thus must be constantly produced by the system these elements comprise... The system would simply cease to exist in any, even the most favorable, environment if it did not equip the momentary elements that compose it with the capacity for connection, that is, with meaning, and thus reproduce them (Luhmann, 1995, p. 11)

For comparison, Venter (2008) has described his work in digitally designing sequences of DNA which, when inserted into bacteria, changed the genetic code of the bacteria and therefore its fundamental characteristics. His goal is to create new micro-organisms with specifically desired characteristics (for instance, microbes which can synthesize fuels for use by humans.) This is clearly an example of what Allen, et al. (2003) have described in terms of using biology as machines. As both sets of researchers seem to agree, even organisms at the level of microbes are quite context-dependent (e.g. the outcome of inserting digitally-designed DNA into a molecule will differ depending on the environment in which it is placed.) But organisms have a more tangible structure than ecological systems. Or as Allen, et al. (2003) explain:

An ecosystem is not a realized structure, in the same way as is an organism. A mature organism is a relatively fixed realization of a type (associated with a given context), translated through DNA into a concrete structure. In an organism there is a fixed being, but there is no such fixation to give a body that is an ecosystem…
An ecosystem is a becoming, not a being (p. 397)

Every attempt at engineering environments begins with a set of assumptions about what is, or should be, possible. Beginning with pre-determined environments is largely what defines artificial or virtual systems. (It is also what defines purely theoretical systems.) Only certain possibilities exist. The environment is predictable, but ultimately sterile. Change will occur within the environment, but not to it. But if both ecological systems and social systems are autopoietic – that is, self-producing – to what degree can they be consciously engineered or designed?

**HOLONS AND HIERARCHIES**

Allen, et al. (2003) make reference to Koestler’s notion of holons as entities which have identities, but which are comprised of smaller parts each of which have different identities, and also act as parts of larger entities with still different identities. (Water molecules are made up of hydrogen and oxygen atoms, and water molecules collectively form pools, ponds, lakes, rivers, oceans, etc.) They distinguish these levels as \( n \) (the level of current focus, which in this case would be water molecules); \( n - 1 \) (hydrogen and oxygen atoms); and \( n + 1 \) (e.g. a pond or river).

As biological organisms we have physical structures that could be seen at many levels of \( n - 1, n - 2, n - 3 \), and so on. Our functional systems (respiratory, circulatory, neurological, etc.) are comprised of organs, which are based on cells, which are formed from molecules, which are comprised of atoms, etc. We also inhabit worlds formed through ideas and symbols which have evolved through millennia. If we cease to operate at any underlying level, from neurological to molecular, it obviously affects our total functioning. And we know that by affecting underlying levels through interventions such as medical care we can restore our functioning as organisms. But changing physical structure at level \( n \) does not necessarily or predictably change the functioning at level \( n + 1 \).
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Biological ecosystems are comprised of the organisms within them, but not in the same way that organisms are made up of cells. The ecosystem around a small pond, for instance, would seem to have greater degrees of openness as a system than the organisms which inhabited it. The fish and frogs in the pond, and the birds, insects, and mammals that visited it, could certainly change and adapt as individuals, and over time as species, but not to degree that the ecosystem as a whole might. If one of Venter’s new micro-organisms were introduced to a pond, both would be affected, but the changes for all of the other species involved would magnify the effect on the ecosystem as a whole due to the increasing complexities involved.

Following this line of reasoning, human social systems would appear to be much more like ecological systems than like organisms. The difficulty with this comparison, though, is that as biological beings, we already inhabit biological ecosystems, just as other organisms do. We need to consider yet another leap in complexity in order even to begin addressing human social systems, as such.

HUMAN SOCIAL SYSTEMS

Animals of many kinds exhibit collective behavior. Insects form hives, birds flock, mammals form herds, pods, and so on. In some ways, human group behavior certainly looks like that of other animals, and probably has many instinctive, biological roots.

Looking at the n + 1 level for any given individual human, though, typically results in a very complex pattern of associations and relationships, many of which happen simultaneously and all of which are interlinked in various ways. (Characterized by roles, I am a son, father, husband, brother, business owner, professor, church member, citizen at many levels, just to begin the list.)

Language is often viewed as one of the key markers that distinguish humans from other animals. While other animals do communicate in many ways, and do coordinate behavior, the abilities to think and communicate symbolically seem to add a great deal to the variety and complexity of human worlds. This would seem to make language, or possibly its larger functions in symbolic communication or coordination of human interactions, a candidate for the material or fabric of social systems. But if that were so, how would we design or engineer a social system by using it?

People talk a great deal. Many people, in fact, appear to spend the greater part of their waking hours each day talking, or communicating through written text in some way. The advent of mobile communication devices which are accessible to general populations around the world has only exacerbated this.

Even without specific research, it would appear that most conversations are fairly repetitive. They deal with topics that have been addressed with those same people or with others in similar relationships, frequently. “How have you been?” “Did you hear this news?” “Have you seen or spoken to this person we both know”, and so on. Sometimes new information is shared; sometimes conflicts are started or resolved. Mostly, though, connections are simply maintained and relations perpetuated.

Each setting (each different social system) creates a different context for different types of conversations. Identifying with, and being identified by others as belonging to, specific social systems means learning to engage in the interactions unique to it.

Dealing with language, as such, though, is highly complex and extremely difficult. We obviously need language, but it is often anything other than clear or exact, which is why
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relying on mathematics is much cleaner. But that requires creating a very different kind of environment.

Most human activity is also habitual and repetitive. In fact, we tend to value our routines and a sense of what is normal or regular a great deal (which is one reason that the concept of “home” probably carries such strong connotations.)

As already noted, by Allen, et al., (2003) engineering begins with a plan. A plan inherently involves language, at least in terms of interpretation, however graphic or quantitative the model or representation might be. So in beginning even to think about addressing human social systems as they are, we have a number of very complicated issues.

1. We are attempting to affect what are assumed to be autopietic systems.
2. We are working some number of layers of complexity above even biological ecosystems (by virtue of their basis in symbolic communication, in some way.)
3. The autopietic features of human social systems seem manifested, at least to some degree, by habitual and repetitive patterns of language and behavior.
4. We have, to some degree, to rely on the use of language as a means to affect systems based at least partly on language.

**DIALOGUE**

Banathy (1996) proposed dialogue as the basis for his approach to social systems design (SSD). (This would, of course, be consistent with the use of language as a means for planning for engineering, as described by Allen, et al. (2003.)) More accurately, Banathy proposed two related but distinct types of dialogue for SSD: generative and strategic. Of the two, strategic dialogue is much more familiar to most people. It is the type used for planning and decision-making of all kinds. It is what creates the “closure of the information space” to which Allen, et al. (2003) refer (p. 295).

Generative dialogue, on the other hand, functions in a much different way. It acts on the environments in which human communications and interactions might take place. Banathy (1996) initially relied on Bohm’s (1996) concept of dialogue as his basis for generative dialogue. As Bohm explained:

I’m going to propose that in a dialogue we are not going to have any agenda, we are not going to try to accomplish any useful thing. As soon as we try to accomplish a useful purpose or goal, we will have an assumption behind it as to what is useful, and that assumption is going to limit us (p. 17.)

Banathy (1996) proposed that generative dialogue should

…lead to the creation of collective consciousness, collective inquiry that focuses on the thoughts, values, and worldviews of the group and creates a flow of shared meaning, shared perceptions, a shared worldview, and a social milieu of friendship and fellowship (p. 219.)

Before going further, a word of caution is warranted. It is relatively easy, and at the same time dangerous, to draw direct parallels between ecological and social systems. It may be that social systems function according to many of the same principles as ecological systems, only at a different level of complexity or based on different elements. If so, they could be mapped as analogous systems, in Rosen’s (1985) terms. It could also be that the parallels are only metaphorical, and therefore useful for discussion but not for rigorous research. (Differences like this get confused often, as in talking about human brains as if they are
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electronic computers, or vice versa.) It is safest to assume that we are dealing with metaphors for now, until these systems can both be better understood.

Regardless of the true natures of either ecological or social systems, we oversimplify both when trying to affect them. This is the problem of taking a traditional engineering (or a traditional scientific) approach, in which we assume that we can effectively isolate and manipulate parts of an autopoietic system, with predictable, cause-and-effect, results. It is the difficulty that becomes obvious when we assume that we can operate human systems of any kind “strictly by the numbers,” only to have to repeatedly fix the same or similar problems, in addition to having to address new problems which arise due to unintended consequences.

Strategic dialogue alone can, of course, produce results. These often happen quicker, at less short-term expense, and with less involvement by different stakeholders than through generative dialogue. Recapping from above, though, it assumes that:

1. There are fixed, agreed ends in mind;
2. The decisions of the planners involved have determined the appropriate limitations and closure on the information space to be used, and;
3. An external design can be imposed on material that is the passive recipient of engineered limits.

As described by Banathy (1996), generative dialogue is not meant to replace strategic dialogue, but to precede it (see Metcalf, 2008). By acting on the environment in which strategic dialogue is to take place, generative dialogue opens possibilities by creating a deeper sense of understanding between the people involved, which often leads to new connections between ideas or ways of thinking, and a sense of trust which makes the sharing of ideas feel less threatening that it might otherwise. When effective, generative dialogue fosters a sense of shared commitment amongst the individuals involved. As changes occur at a strategic level, they are less likely to be dismissed as “someone else’s problem,” and more likely to be attended to by those who feel a vested interest in them.

In a world that seems ever-more focused on short-term efficiency and optimization, generative dialogue may appear extravagant, wasteful, or even pointless. The proponents of this view, though, rarely go back to calculate the waste produced by ineffective short-term efforts that miss targets or goals entirely. Assuming that their approach is the only valid one, they simply continue to launch new efforts of the same type.

Because the world is both more dispersed, and at the same time connected, the need for generative dialogue (or some alternative that creates a similar result) is critical. There is very little left in our human world that remains in isolation. Economic markets are global, as are issues of health, climate, energy, food, etc. Specific problems still need to be understood, targeted, and resolved, but within a context of ongoing attention and shared responsibility. Competition remains useful, but in a context which understands that survival is ultimately a cooperative affair.

Despite our vast technical expertise, we struggle as a species with conflicts at both biological and symbolic levels. Like other species, we fight for territory and food. Unlike other species, we kill each other over religious differences. Trying to simplify these issues to the levels of our tools and models does not do them justice. (A horse and carriage and an automobile are both means of transportation involving horsepower, but dealing with both as though they were the same thing is only useful at a very general level.)
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We may be a long way from fully understanding human social systems as such, but learning to make distinctions between mechanistic and ecological systems, even at the biological level, is a step in the right direction.

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SYSTEMIC METAMETHODOLOGY FOR METHODS DESIGN

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ABSTRACT

There is a large collection of systemic and non-systemic methods, and even a metamethodology for the adequate selection of a systemic method for each problematic situation, but at the same time there is a void of systemic tools for the design of methods. We have two main objectives in this article; the first one is to document some of our initial advances in the design of a tool for the innovation of methods, a metamethodology for systemic design of methodologies that link systemic and non-systemic methods, and its parts. The second objective is to open a constructive dialogue on this issue with other systemic researchers that are working on this theme, we are interested in their advances, and we also want to exchange information and critical points of view with an open mind to different approaches. The design of the metamethodology is under the transdisciplinary approach to systems science.

Keywords: Method, methodology, metamethodology, cybernetics, transdisciplinarity

INTRODUCTION

Through the publication, of this article we want to promote a debate in the systemic community on the systemic design of methods. As we all know, many systemic and non-systemic methods have been developed in the last fifty years, but it is difficult to find a systemic methodology for the design of methods. We are presenting a first stage of a systemic metamethodology to design new methods that link systemic and not systemic methods, and their parts.

Many systemic researchers and professionals are using different types of systemic and non systemic methods to address different types of problem situations. Most of them, just apply existing methods to problem situations as practical operators do when they don’t have the necessary knowledge to challenge, and transform existing methods for specific situations. Today, there is a valuable collection of systemic and non systemic tools for systems design and improvement, that we can use for the systemic transformation of different types of systems under a particular context. For the design of new specific systemic methods, we can use the knowledge we already have from existing designs of systemic and non systemic methods. We can also examine each one of them under a critical approach to learn from their qualities and limitations, and we can also learn from our own experiences when we have applied different types of systemic tools in a variety of problem situations.
Systemic Multimethodology for Methods Design

If methodologies are the tools for the creation and validation of scientific knowledge, it is important to understand the different approaches to science as knowledge. For that reason we compare different types of scientific knowledge such as disciplinary, interdisciplinary, and transdisciplinary, basic and applied knowledge, for physical, biological, and behavioral systems. Each type of scientific knowledge has implications for the design of scientific tools. The most complete approach is applied transdisciplinary knowledge, as a conceptual context for the design of systemic methods.

It is useful to make a conceptual distinction between method, methodology, and metamethodology, to understand the scope of each of these concepts. In this article, the meaning of method is a transformation process of a System through a sequence of steps toward a specific aim this objective can be theoretical or practical. Through a method we can offer an answer to the planning question ¿How?. A methodology is the study of methods, and a metamethodology is the study of methodologies.

The meaning we give to the concept design is: a creative process of integration of concrete (systems) and/or abstract (models). The transformation process of design, implies a radical change in the architecture of a system, in this case of a method to create a new method. A new system has a different number of elements and relationships, with each new architecture the system new properties emerge. The process of design is developed under a qualitative open systems approach, each new element and relationship comes from the environment, through the use of the metamethodology we can integrate systemic and non systemic methods and their parts. The aim of the systems design of methods is to provide specific process to give an adequate answer for each specific problem situation.

One important issue we need to address in the design of a new method is the congruence of the new methodological tool. For that reason an ecosystemic metaphor was also designed as a conceptual guideline for congruence in the design. A basic question we need to answer is: What was the origin and the main influences for the design of a systemic metamethodology for methods design?

CONTEXT OF THE SYSTEMIC METAMETHODOLOGY FOR METHODS DESIGN

Kurt Flood and Michael Jackson (1991) Total Systems Intervention, TSI, was one of the main influences for the design of this systemic tool. When Michael Jackson visited México at the beginning of the nineties decade, we could appreciate the great value and richness of their systemic design of TSI: They designed a taxonomy for systemic transformation tools. Each of the main systemic tools that where developed in the last fifty years was scrutinized under a critical approach to learn of their qualities and limitations. They developed a taxonomy to classify systemic methods. Their taxonomy of systemic methods is based in the use on some of metaphors or analogies proposed by Garreth Morgan (1997). It also uses a critical systems point of view, and some of their principles such as complementarity, social and environmental consciousness, and the promotion of human emancipation.
TSI metamethodology has the following stages:

- The first stage is for the selection of an adequate metaphor that can be used as an analogy for the problem situation.
- The second stage is used to select a particular systemic tool classified under one of the metaphors.
- In the third stage, the selected systemic tool is applied to the problem situation. The feedback is among all the different stages.

The TSI metamethodology, uses five main metaphors to classify a group of systemic tools. The analogy or metaphor can represent a machine, a living being, a brain, a culture, a jail, etc. (table 1). Michael Jackson (1991) also mentioned that other metaphors such as the ecology can be applied.

| Table 1. Classification of systemic methodological tools (Flood and Jackson, 1991) |
|---------------------------------|---------------------------------|---------------------------------|
| **M/S-C** | **METAPHORS** |                                    |
| Simple and Complex | Mecanicist y neurocybernetic | Organic and cultural | Jail |
| SIMPLE | Hard methodologies | Soft Systems Methodologies (SSM) | Critical Heuristic Methodology |
| COMPLEX | Viable Systems Model (VSM) |                                    |

Note: Recently Michael Jackson (2000), instead of using three columns is using five, but the content of the fourth and fifth columns is very limited.

Flood and Jackson (1991) defined criteria with an open mind for the TSI design, they avoided the discussion on the relative merits for each type of methodology such as hard or a soft methodology approaches. Under the complementary criteria they are different and complementary. They criticized the non-systemic tools for their simplicity and lack of deepness, they called them modes for their unstainability.

Many professionals are using many types of non-systemic tools to address different types of problem situations. Those techniques are clear and well documented, and can provide particular answers to simple problem situations.

In the didactic process of teaching different types of systemic tools we found that is difficult to explain what types of methodologies are simple or complex. For all of this reasons we decided to create a new systemic tool for the design of new methods, that link systemic and non-systemic tools using the principle of complementarity.

Another influence for the design of a new systemic tool was the Soft Systems Methodology, MSS of Peter Checkland (1980). In the fourth step of his methodology he incorporates other tools for the design of conceptual models.
Description of the systemic metamethodology for systems design

Its design process began in 1995, with the intention to make a complementary synthesis between systemic and non systemic tools, and also with the pedagogical aim to teach the students, researchers, and professionals in a friendly way how to combine different types of methods for and adequate solution of problem situations. The name of the tool was: C5 Metamethodology (in spanish Contexto, Ciclo, Complejidad, Conciencia y Calidad) or (in english Context, Cycle, Complexity, Consciousness, and Quality). This systemic instrument has three main stages:

1- Context definition. Geocultural and temporal (Cycle of Life de), the aim of this stage is to select the system or object of study/transformation and its boundaries as a holos (system, subsistems, environment).

2- Design of the Theoretical and Methodological Framework. Through the adequate selection of systemic and non systemic methods and their integration for the specific problem situation. For this a complex process of selection and integration was designed, that we will describe in a future article.

3- Application of the designed method. The aim of the transformation process is to obtain a better organized or more complex system, to change the attitude and knowledge of the people who where involved in the process of change who are going to operate and receive the benefits of the new system, to improve their Consciousness, and to improve the integral quality of the new system. Its is permanent an iterative process of improvement under real conditions in a dynamic environment.

Table 2. Stages of the C5 Metamethodology for methods design (Peón-Escalante I, 1995)

<table>
<thead>
<tr>
<th>Stage 1. What</th>
<th>Stage 2. How</th>
<th>Stage 3. Iterative application of the designed method</th>
</tr>
</thead>
<tbody>
<tr>
<td>The group involved in different aspects of the problem situation defines the aim and boundaries of the system transformation process as an holos (system, subsistems and environment)</td>
<td>With the aid of a decision making tool that has three axis X- Metaphors (for the selection of systemic tools) Y. Cycle of Life (for the selection of non systemic tools) Z- Cybernetic Process (for the participatory action –research architecture of the method)</td>
<td>The designed method as a heuristic cybernetic process of change is applied to improve the problem situation toward a complex, conscious, and qualitative solution.</td>
</tr>
</tbody>
</table>

Table 2. Stages of the C5 Metamethodology for methods design (Peón-Escalante I, 1995)
THEORETICAL FRAMEWORK

The theoretical framework gives consistency to the method design. In the theoretical framework we apply the following concepts.

Second order Cybernetics or cybernetics on the cybernetics. (Von Foerster H, 1995). A participatory action-research architecture of the method is used. (Fals Borda O, 1998). This type of process uses a critical approach and is designed as a parallel iterative heuristic process (Stacey, 1996) of learning when we confront the method of design with the real conditions of the system in which we intervene. The first level of the cybernetic process as a closed System is oriented toward control, and the second level as an open system is oriented toward an adaptation, innovation and learning process of change. (De Greene K, 1982). In the first and second level of cybernetic transformation we have a permanent learning dynamic through the feedback loop that links models and concrete systems under the specific dynamic conditions of the real world. (Espejo R, 1996).

Life Cycle Metaphor (Peón-Escalante I, 1995)
Through the use of the analogy or Life Cycle Metaphor we can represent different stages in the development cycle of different types of systems. We can be aware of the violent and slow process of change of many types of systems under different conditions. The violent process of birth and collapse (Diamond J, 2005) is contrasted with the slow processes of growth and maturation.

![Figure 1. Life Cycle Metaphor (Peón-Escalante I, 1995)](image)

1. Emergence-Design
2. Growth- Improvement
3. Maturation-Maintenance
4. Death-Collapse

Ecosystemic Metaphor (Peón-Escalante I, 2006)
We designed this metaphor as a conceptual guideline for the design of robust methods. Its design uses as a model the evolutive dynamic of ecosystems (Lovelock J, 1990). Some of its main principles are:
Systemic Multimethodology for Methods Design

Geocultural Territoriality. Each type of ecosystem exists under specific natural conditions in a territory, they are viable stable systems with a permanent identity. In the territories where they live, the human communities have developed cultures linked with the natural conditions of their habitat. For the design of specific methods for specific problem situations we have to be aware of the geocultural territory or context of the system in which we want to intervene.

Unity in diversity. A synergetic type of design implies unity in diversity through complementarity. When we select and link different types of systemic and not systemic tools of change as a network process (Lipnack y Stamps, 2000) we can obtain emergent properties in the new method as a complex process of learning and change (Morin E, 1998).

Dynamic equilibrium and sustainability. The design of the method under the architecture of a participative action-research process, or an open cybernetic heuristic process is a design toward dynamic or homeostatic equilibrium. In a dynamic world, sustainability is only possible through permanent adaptive change toward equilibrium. Each method we design has feedback loops for learning and adaptive change. The architecture of the method has three main stages:

- A model as a conceptual planning context for control and learning
- Action or implementation of the plans in the real world
- A network of feedback loops linking the planning and action stages for the learning, control, adaptation and innovation processes

Transdisciplinary vision. There are broad and limited visions on the meaning of science (Scientia or knowledge). Many scientists and researchers believe that the concept of science applies only to the occidental approach to knowledge of the last three hundred years, a reductivist type of knowledge. For other researchers including us, the meaning of knowledge is much broader. (Nicolescu B, 2002). The transdisciplinary vision of science or knowledge is not only interdisciplinary but also theoretical and practical as applied science; it includes also other types of knowledge such as empiric, philosophical, esthetics, etc.

APPLICATION OF THE SYSTEMIC METAMETHODOLOGY FOR METHODS DESIGN, AND DISCUSSION OF RESULTS

Its main application has been in the graduate programs in systems engineering and occupational health in a very large public university in Mexico, the National Polytechnic Institute, IPN. Many of the students who work with us on their thesis learn how to design a systemic methodology. Our students have different types of technical, computing, health, administrative studies and professional experience; they work in small and large public enterprises working on engineering projects, health and educational institutions, in agricultural, industrial and services projects. The metamethodology has helped them to work not only in their thesis but also in their professional projects. Our students come from different parts of the country and also from other countries from South, Central America and the Caribbean.

They apply the three main phases of the metamethodology for:

- The definition of boundaries In the system they chose, they define the boundaries of
Systemic Multimethodology for Methods Design

an holos (the boundaries of the systems, subsystems and environment). It is difficult process to chose with precision an open and integral system in which they can intervene. In this stage they give an answer to the important planning question: What?

The design of the Theoretical and Methodological Framework The system they chose can have different types of problem situations. Trough the application of a group of decision tools we call the cube, they can chose an complementary group of systemic and non systemic tools adequate for the problem situation. Then we integrate the different tools and its parts as a heuristic participatory action research method and its conceptual guideline.

Aplication of the designed method. In this stage it is important to apply a participative iterative process of action-research toward the improvement of the system. Through the application of the method we change its organization toward a higher degree of order or complexity, and the human system toward a higher degree of cultural awareness, or conscience. A system that achieves a higher degree of complexity and consciousness (De Chardin P, 1966), achieves also a higher degree of integral quality toward sustainability. (Peón-Escalante I, 1996).

The main results in the elaboration of dozens of thesis and professional projects has been positive in general terms. There are many things we want to improve, such as a documentation of many systemic and non-systemic tools, the documentation of complementary techniques for the different stages of the metamethodology. We also want to have a critical and propositive feedback on the concepts and on the results in the applications.

CONCLUSIONS AND SUGGESTIONS

Through the systemic design of specific methods for an intervention process in a variety of systems, many researchers and professionals can create adequate solutions to specific problem situations. To do this they need to improve the knowledge they have on systemic and non-systemic tools. We have found out in the training process of researchers and professionals that when they have a basic knowledge on systemic and non systemic tools they can learn very quickly how to use the Systemic Metamethodology for Methods Design.

At this stage the metamethodology, is under a process of improvement, we are designing a group of specific tools for each of its stages, and we also are designing a data base on different types of systemic and non systemic instruments of change. We are in touch with a group of researchers in different fields of knowledge and professional activities to receive their feedback for in the design and application process of the systemic metamethodology for methods design in different fields of action-research.

We want to give a special recognition to COFAA-IPN for the resources they gave us for our research.
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CANNIBALIZING CHILDHOOD’S FUTURE AS RISING TO FALLING ROPE

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ABSTRACT

With the relaxing of restraints on advertising to American children during the Reagan Administration, marketers have pulled out all the stops in targeting the young. This paper examines the commercial exploitation of childhood and consequences as a case-in-point of the 2nd Law of Thermodynamics at work. Drawing on physical chemist Peter W. Atkins’ 2nd Law metaphor as heavier weight falling linked to lighter weight rising, we contend that revenue streams driven by sophisticated marketing to children is, in large measure, at the expense of childhood, families, and the nation’s future. By systematically bracketing off all but the bottom line, we’ve become “a society that is eating its own children in the name of profit.” But, if indeed, the rising corporate order satisfies the 2nd Law by using the lives of children and families as convenient sinks for dissipative effluents, what is the modus operandi? What is the rope linking the rising and falling weights in Atkins’ metaphor? The proposed answer lies in evolving techniques capitalizing on an instinct that’s so natural, it knee-jerk bypasses most, if not all, critical judgment. Formally it’s called “the Principle of Least Effort,” the urge to preserve what was once precious food energy by seeking out and indulging in shortcuts. The techniques are especially effective with children.

Keywords: 2nd Law metaphor, food webs, marketing, “Principle of Least Effort,” shortcut.

TWO WEIGHTS, A PULLEY, AND A ROPE

The commercialization of childhood shares more than a metaphorical connection to food webs that extend back to the origins of life. As the 2nd Law of Thermodynamics stipulates, you can’t grab order anywhere, anytime, without munching on something. All living organisms have to eat. When we eat, we absorb order as usable energy and structured materials like protein, fat, carbohydrates, in our food. Plants feed on the sun. We feed on the plants that feed on the sun, or on the animals that feed on the plants that feed on the sun. Most species don’t eat their own, though there are exceptions (a hungry male lion in times of scarcity will feed on his, or some other male’s, cubs). Barring extreme situations of starvation, as with the Donner Party, stranded by an unexpected blizzard in the Sierra Nevada in the Fall/Winter of 1846-7, literal human cannibalism is, by and large, off the table. But, that doesn’t mean there isn’t a lot of dining going on.
Cannibalizing Childhood’s Future

When we eat, we consume the means for creating and sustaining order both within ourselves, and in the world at large through well-organized individual and collective behavior. Because the 2nd Law insists that concentrating order one place must, and will be, paid for by dissipating it someplace else, the price of living is the disordering / killing of whatever is served up as our food (Arnheim, 1971; Atkins, 1984; Nicholas and Prigogine, 1989; Schneider and Kay, 1995; Schneider and Sagan, 2005; Schrödinger, 1945; Swenson, 1998).

![Figure 1.](image)

A good way to see this rising up linked to falling down is a metaphor of two weights connected by a rope wrapped around a pulley (Fig. 1). On one end of the rope hangs a weight. On the other end is another and heavier weight. Under the pull of gravity, the larger weight falls down, but its falling down allows the smaller weight to get pulled upward against the direction gravity would like it to go. Living organisms represent the weight going up. Food represents the weight going down. The rising weight of concentrating order, compensated by the falling weight of dissipated order, satisfies the 2nd Law and life moves on, evolves.² And has continued to evolve to the point where the rope linked rising to falling has transcended the realm of biological organisms and gone into the domain of social organisms, one of the most significant of these being the legal person called a corporation.

Public, for profit, corporations are legally bound to maximize profits for their owners, the shareholders (Bakan, 2005).³ To acquire those profits in today’s all-out competitive marketplaces, the corporation must do everything it can to optimize efficiency as the difference between money in – sales – and money out - costs. The successful company (Wal-Mart comes to mind) represents a super-concentration of order as highly organized,

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1 For more on the metaphor, illustrated with two pulleys to better show what happens when the rope is cut, see (Atkins, 1984, 167).
2 See (Corning, 2000) for a proposed alternative “thermoeconomic” view of the relationship between energy and evolution.
3 While privately held companies are free to do what they want, competition will weed out all but the most bottom line focused. Non-profits still have to balance the books as the endless barrage of fund raising campaigns points out.
purpose driven, energy, materials, and people. But, if indeed, the 2nd Law be true, and thus far no one, at the scale of our own lives, has ever found a violation, then where is the chaos compensating the risen corporate order? Who or what is paying the bill?

ENVIRONMENTS OF CONVENIENCE

The answer is to be found in “the environments” surrounding, supporting, providing the inputs and receiving the outputs of whatever’s cranking out the profits. In what is usually considered “the environment,” non-renewable resources like oil and coal are being extracted and consumed. And like all biological organisms that have to get rid of what they don’t use, so too do corporate organisms have to dump the wastes of whatever’s not incorporated into their products. The environmental chaos of polluted air and water, both inside and outside China (a vast plume of China generated pollution year-round migrates across the entire Pacific Ocean to the U.S. west coast), spins off the massive pouring of order into products that far exceeds measures that deal with compensating dissipation (Hotz, 2007; Kahn and Yardley, 2007). The planetary fever called global warming is another case-in-point of our industrialized imbalance of attention, shoving dissipative impacts under the economists’ externalities rug (Beard and Lozada, 1999; Daly and Cobb, Jr., 1989; Georgescu-Roegen, 1971).

EATING OUR OWN FOR PROFIT

But, there are other, not so easily recognized, environments of convenience that slip under the environmentalists’ radar. One of those environments is the child. The industrialized exploitation of childhood represents the extraction of order from children and the dumping of wastes into them. The sapping of childhood is the weight falling down. The absence of legal and effective restraint on the use and abuse of the most vulnerable has turned us into a society that is eating its own children in the name of profit.

Whereas not very long ago, in particular before the Federal Communications Commission under Ronald Reagan opened children up to all out marketing forces by deregulating children’s television, there was at least some respect for the sanctity of childhood, a kind of so far and no farther. No more. There are effectively no limits to how far corporations will go to sell their products, regardless. With the door wide open, the full firepower of science-fueled marketing is being aimed at consuming the young.

MINING THE RELATIONS

In her book, Consuming Kids: Protecting Our Children from the Onslaught of Marketing & Advertising, Susan Linn zeroes in on one highly exploited technique marketers use to get parents to buy what they’re selling. It’s called “The Nag Factor.” The phrase is based on a 1998 media research study done not to help parents cope with nagging “but rather to help retailers exploit nagging to boost sales” (Linn, 2005, 33).
One of the companies conducting the study, Western International Media (now Initiative Media Worldwide) issued a press release titled “The Fine Art of Whining: Why Nagging Is a Kid’s Best Friend.” In it, the researchers identify the brands of parents – “Indulgers,” “Conflicted,” “Bare Necessities,” “Kids’ Pals” – most vulnerable to nagging, the products most associated with nagging, and success rates (Western International Media, Cited in Linn, 33; see also Bakan, 119-24). The Nag Factor investigation revealed that 21% to 40% of jeans, burgers, and other products sales result from nagging. Four out of every ten trips to place-based entertainment venues like the Discovery Zone and Chuck E. Cheese result from pester parents. Ditto for one out of three trips to fast food restaurants. The apparel sales pester pump up is 31%. For home video sales, it’s 30%. (Western International Media)

Because the Nag Factor study, as Linn notes, “found that ‘the impact of children’s nagging is assessed as up to 46 percent of sales in key businesses that target children,’” it generated a lot of marketing world attention (Morales cited in Linn, 34). A marketing newsletter Selling to Kids headlined a story “The Old Nagging Game Can Pay Off for Marketers” (Frazier cited in Linn, 35). The piece fastened on two-weeks of nag counting diary keeping by 150 mothers with children in the age range 3-8. The total nag count came to 10,000, an average of 66.67 nags per mom, 4.7 nags per mom per day. The study was further broken down into nag type: “persistence,” and “importance” (as in “all my friends have TV sets in their rooms, why can’t I?”).

Susan Linn wishes that “The Nag Factor,” or “pester power” as it’s also known in the trade, was some kind of anomaly. “It’s alarming,” she says, “to think that people would actually want to wreak havoc in families just to make a buck.” Far from being the exception, it is just doing business as usual. Linn quotes the senior brands manager for Heinz’s catsup division, Kelly Stitt, who had this to say in the Wall Street Journal: “‘All our advertising is targeted to kids. You want that nag factor so that seven-year-old Sarah is nagging mom in the grocery store to buy Funky Purple. We’re not sure mom would reach out for it on her own’” (Eig cited in Linn, 35).

“It’s distressing,” she continues, “that someone can be so matter-of-fact about a highly researched and effective assault on the fabric of family life. Yet, within the advertising industry, Stitt’s attitude is not unusual. If advertising executives have any doubts about ‘pester power,’ these seem to center only on whether it’s effective, not whether it’s ethical” (Linn, 35).

Another technique called “relationship mining” aims at uncovering and then exploiting the motivations of different family members (Neville cited in Linn, 36). Its purpose is to do an end run around parental resistance, ideally leaving them clueless as to what’s really going on. If, as Linn points out, the moms in the “Nag Factor” study were approached by a researcher who said: “I’m conducting research whose results will make your life more stressful because your children will be better able to nag you to buy them things,” or, ‘I want to mine your family relationships to better understand how to get you to agree to buy your kids things you don’t really want to buy them,’” how many would be willing to participate? (Linn, 36).
LARGER GOINGS ON

Does the 2nd Law metaphor of rising weight linked to larger falling weight bear on pester power and relationship mining as instances of larger goings on? Let’s take a look. To get the accounts of corporations wanting to maximize the selling of their stuff, advertising agencies need to show their prospective clients that they have an edge. By studying with keen and sustained attention, parent/child relationships they will stand a better chance of finding and deploying effective strategies to wilt parental control and resistance. The weight going up is increased sales and profits. The weight going down is the dissipation of parental control. The injection of chaos as stress from persistent, pester fueled, conflict. And if the father doesn’t see anything wrong with what the kid wants and the mother does, or vice versa, this adds stress not only into parent-child relationships, it helps to break down marital bonds, especially if one parent is strongly opposed. The child will be all too willing to exploit the divided parental front in favor of the parent who’s a better prospect for giving him what he wants. The exploitation can be especially injurious when the parents are divorced.

In a 2nd Law frame, what we see here is product pushers extracting profitable order at the expense of the nation’s families and children. As Linn puts it: “For those of us who free-associate, the metaphor of ‘mining’ family relationships is particularly and painfully evocative. Families are perceived as a repository (the mine) containing valuables that are there for the extracting—and exploiting” (Linn, 36). The seriousness of this deep-seated absence of ethics, where marketers systematically bracket off potentials for harm, lies in its being a microcosm, a particularly egregious case-in-point, of what’s increasingly going on across the board of scientifically fine tuned strategies for zeroing in on sales targets. While the decoupling of strategies and consequences is a game not recently concocted, what is new is the vertically rising techniques for exploitation.

NOT REALLY NOT MARKETING’S PROBLEM

One, not hard to miss, accumulation of entropy as harm spinning off the exploitive targeting of children – by no means the only one - is the epidemic scale rise of overweight and obese kids and such ill-health consequences as type 2 diabetes. While it’s hard even for free marketers to deny the stats, the blame they claim falls not on the machinations of marketing, it’s in the failings of parents. It’s their fault if their kids get overweight or obese from overindulgence in fat and sugar laden foods. As one New York Times responder to a Paul Krugman column on the obesity epidemic, “Girth of a Nation,” wrote: “‘Obesity,’ is strictly their problem, not the food companies’ or any other American’s. Food companies should remain free to market their products, including ads targeted at young people, thus exercising their right to free speech (advertising) and their right to free trade (the production of materials that individuals willingly buy)” (Kellard, 2005).

But is it really so straight forward? The marketing assault on children is relentless and ubiquitous. “The problem,” Linn writes, “is that while parents are trying to set limits,
marketing executives are working day and night to undermine their authority…So which battle should we pick? Should we pick the violence battle? Or the language battle? The candy battle? The sugar cereal battle? The Lunchables battle?4 The sexualized clothing battle? The World Wrestling Federation battle?” (Linn, 38). Or the TV time watched or what’s watched battle? The stay away from website war? The “M” (mature) rated video game played at friend’s house struggle?…

EASY RULES

If indeed, as activists in the über-war against the commercializing of childhood contend, corporate gain is at child’s expense, this fact of life does not explain the modus operandi. Is there a largely unrecognized force underlying the success of exploitation? There is.

In a nutshell, what is at work backstage is something that’s so obvious, so knee-jerk natural, that we don’t see it unless it’s pointed out. That something is the urge to take least food energy consuming paths whenever, wherever, they present themselves. Formally, it’s called “The Principle of Least Effort” (see Mann, 1993, Robbins, 2000, 2006; Zipf, 1949, 1965). Once a supremely successful survival strategy that we still retain from our long history of hunting and gathering, today, in our technology transformed world, the instinct is both out-of-whack with the times and exploited to the hilt.

ROPE’S ROLE

In the two weights, a pulley, and a rope, metaphor, our attraction to anything promising us an easier route is the rope. By offering us an endless stream of products that make life easier, the corporate order rises. Because human order in brain, body, and health is sustained by effort, by consuming the mass of products that, one by one, remove more and more effort, the human order falls. By giving us what we want, or have been convinced through ever more sophisticated marketing to want, we’re systematically losing it for no longer having to use it, children not excluded.

If you look at virtually every instance where Susan Linn says that parents are engaging in battles with media onslaughts, and filter them through the color of ease, what you see is that the force drawing the child to the harmful activity (or better, absence of activity) falls in the direction of it’s easier. The same applies to parents who either give up the struggle or don’t, for one reason or another – time, exhaustion, ignorance - ever engage what’s going on deeply enough to see what researcher / activists like Susan Linn have uncovered.

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4 Lunchables is a food as entertainment friendly product that was awarded a Lifetime Wastemaker Achievement Award in 2001 by the Massachusetts Public Interest Research Group (Linn, 37). The fact that parents object to Lunchables high cost and questionable nutrition is viewed from a marketers perspective as a plus because their disapproval, of course, makes the kids want it more.
Cannibalizing Childhood’s Future

DIRECT TO REPTILIAN

Successful marketers, whether they realize it or not, tap hard into the knee-jerk reptilian / emotional limbic “old” portions of the brain we share with other members of evolution’s tree. With children - the younger the better - this is much easier. The thinking, wrapped around old brain, cortex doesn’t stand a chance. It has yet to be developed. It all starts at the very earliest ages, as today’s kids are never left alone long enough to start cultivating the synaptic pathways that might lead them into rejecting, or at least doubting, the equation of consuming with good living, more consuming with better living, and shopping ‘till dropping, whoever dies with the most things, wins. That linkup might lead them down the dangerous to economic growth path of grasping the reality that they are being used, their capacity for critical thought, drained, their ability to feel, deadened, their motivation to create, squelched, their power of imagination, undeveloped, their attention span, withered, their physical health, squandered.

AND THE WANING OF PLAY

Had those critical pathways been established early on, there’s the revenue stream risk that as these children enter their teen years and beyond, they may come to the realization that the commercialization of their lives has eliminated, or seriously crimped, what is arguably the most vital factor in the developing mind and body: play. “Play,” says Ms. Linn, “is a fundamental component of a healthy childhood and linked inextricably to creativity. The ability to play is central to our capacity to take risks, to experiment, to think critically, to act rather than react, to differentiate ourselves from our environment, and to make life meaningful...I place marketing’s impact on children’s toys and play among the most dire consequences of commercial culture” (Linn:61).

DRAW OF THE SHORTCUT

Why does Linn say this? The answer has to do with children taking easier routes when it’s offered to them. Today’s hi-tech playthings make it easier for them to get the satisfaction they want without the effort children in the past, with their less technologically active toys, games, and media, had to exert. In a word, the hi-tech playroom lets kids – and their parents – take shortcuts. And don’t we all like shortcuts?

Although the first edition of The Plug-In Drug was written more than 30 years ago, an eon in techno-time, author Marie Winn captures the essence of loss thanks to the escalating incursion of toys that do more and more, substituting for the efforts that children once had to exert. She calls the process a “Gresham’s Law of Child Activity” in that passive amusements, whose technology based “activity” demand less from the child to sustain amusement, drive out more child activity demanding amusements. “Since passive amusements,” says Winn, “require less effort than active ones, human nature dictates that, all things being equal, doing something easier is preferable to doing something harder” (Winn, 1977, 186).
Observe a girl playing with a simple wooden truck who is presented with a complicated mechanical locomotive. Whereas she had been obliged to amuse herself by pushing the symbolic vehicle around the floor, devising an imaginary route in and out and under furniture (providing her own sound effects), now she watches the new toy with fascination, amazed by the smoke spouting from the stack, charmed by the rhythmic toot-toot of the engine, delighted by its ability to propel itself backward and forward (Winn, 186-7).

But soon, Winn continues, the child gets bored with the mechanical locomotive. Its repertoire of tricks is limited. She wants a new toy that does more than move, blow smoke, and toot. This was not the case with the do-nothing wooden truck because the only thing limiting what it can do is the child’s imagination. Unfortunately Gresham’s Law of Child Activity kicks in and makes it hard to return to the more imagination demanding do-nothing toy. “For though the attractiveness of the [active] plaything,” writes Winn, “is brief, there is something so compelling about the passive pleasure it affords the child that the appeal of another toy requiring active participation is diminished…Passive play experiences inevitably make active play less appealing, and therefore less likely to occur spontaneously” (Winn, 187).

**PROCESS IS BLIND, MANIPULATORS ARE NOT**

Because the powerful draw of the dangling shortcut to gratification skips the cortex, zeroing in on the reptilian to seat of emotion (limbic) connection, the ad and marketing squads key in with a vengeance. As Dr. David Walsh, president of the National Institute on Media and the Family based in Minneapolis puts it, “emotion focuses attention, determines what we remember, shapes attitudes, motivates, and moves us to act” (Walsh and Gentile, 2004). Even though they may not formally know what’s going on in the brain in response to their ads, advertisers, through trial and error, have discovered that appeals to reason don’t work, especially in competition with messages that massage the limbic. “Because emotional responses don’t engage our reason,” says Walsh, “they can easily slip in undetected under the radar of critical judgment. Then they subtly but powerfully begin to shape the way we view [a] product without our even being conscious of the process” (Diamond and Hopson cited in Walsh and Gentile).

This under the radar cortex skipping is especially effective with toddlers. Because the synaptic pathways are being furiously formed (a two-year-old’s brain burns calories at twice the rate of an adult’s), creating the “codes” that link product to satisfaction in the very young before a competitor’s product locks in the synapses may be critical to long term market success (Diamond and Hopson cited in Walsh and Gentile; see also Rapaille, 2006).

Once neuronal pathways associated with a product are established, just as we physically will take shortcuts when offered, our brains, as Walsh puts it, will take “mental shortcuts.” These shortcuts save energy because new pathways don’t have to be established to achieve a desired result. Shortcuts, mental or physical, represent the path of least effort, and will be taken without cortical intervention because the act of making new
synaptic connections, when not needed, is not energy efficient. Significantly, “the process [of creating and then exploiting the “soft wiring,” the neuronal networks shaped by experience,] is blind. The manipulators of the process are not” (Walsh and Gentile).

And that’s the rub. It’s relatively easy to see how the mass of products eliminating the need for physical effort in an ocean of energy rich food and drink sums up to health’s downfall. It’s much harder to certifiably pin the tail on the donkey of downside to products capitalizing on either hardwired shortcuts (the powerful draw of anything relieving us of the need to think) or softwired shortcuts (previously wired connections between emotion and product, as in tot getting pleasure from watching cutey creatures on television). Since the ad and marketing minions slip in undetected by the newest and weakest brain overlay, the cortex, the product push easily avoids raising red flags on the possibility of serious and escalating harm.

PATH OF A DRUG

In *Born to Buy*, Juliet B. Schor writes that “We have become a nation that places a lower priority on teaching its children how to thrive socially, intellectually, even spiritually, than it does on training them to consume. The long term consequences of this development are ominous.” From the first grade on up, America’s youth “have emerged as the most brand-oriented, consumer involved, and materialistic generations in history,” topping the list globally. Closely tracking the rampant commercialization of childhood, “evidence of distress among children has been mounting. Rates of obesity are at epidemic levels. Diagnoses of attention deficit disorder and attention deficit hyperactivity disorder have risen dramatically, and record numbers of kids are taking drugs to help them achieve self-control and focus” (Schor, 2004, 13).

Although critics, like Drs. Linn and Schor, of the increasingly sophisticated targeting of youth as powerful engines of sales, point well researched fingers at both the exploitation and its dire consequences should practices continue on, business as usual, this paper aims at setting up an interpretive frame that can add weight to their contentions. What that frame tells us is that the commercialization of childhood is in reality a feeding frenzy that is cannibalizing childhood’s future. Because effort in any activity is the cost of moving mind, body, or society, uphill against the tide of losing it for not using it, the escalating / accelerating deluge of products and media selling themselves on the promise of eliminating one kind of effort or another is the rising weight of industrialized order coupled to the falling weight of dissipated human order, an exploitation that is particularly egregious with children.

How does the coupling work? It works by the fact that effort involves pain and we, adult or child, do not like pain. The pain reminds us that we’re burning once precious food energy. Without the reminder, in a world of uncertain meals, cavalier burning of calories would be a prescription for not getting over the scarcity humps. Offer us something that relieves us of pain, or even better, promises us pleasure, instant gratification, even better, and, like those moths to the flame we’re drawn, no questions asked. The child presented with the choice of active toot tooting, moving, smoke blowing, locomotive will drop the
do-nothing symbolic toy because the do-something toy relieves the need for putting up with the discomfort, however slight, of imaginative, creative, effort.

Because, as Ms. Winn observes, the entertainment value of the do-something toy is transient, but going back to the do-nothing toy is tedious, a demand for ever more active amusements is, to the delight of technologists, toy makers, and marketers is created. Jump 30 years into the future, from the time when toot tooting locomotives could for a time entertain, to today’s robotic playthings, and what begins to appear is a continuous, faster and faster, intensity of activeness in technology driven amusement joined at the hip with ever more sophisticated marketing muscle. But its not just discrete playthings, it’s the soaring incoming stimulation of everything impinging on children, parents, and everyone else. We demand more and more, get bored faster and faster, because the naked human, physical, mental, and social order continues to fall. The path is that of an addictive drug.

TV AS MOMMY

The knee-jerk conventional wisdom is not only that advancing technical “activeness” doing more for us is ipso facto good, it is also that we, children included, can absorb the escalating intensity and still, in our essence, either remain unchanged, or be changed for the better. Although the American Academy of Pediatrics recommends no exposure to television before the age of two, millions of parents either don’t heed or, more likely, are unaware of the warning. They expose their infants to hi-tech, “edutainment” media on DVD, “electronically sugar coated ‘learning,’” as educational psychologist, Jane M. Healy puts it (1998, 53), from not long after emergence from the womb under the massively marketed belief that it will give their kid a leg up on getting into Harvard. Television programs are now aimed at babies well under the age of two. With synaptic pathways furiously gelling, one significant upshot from all this early exposure may be the infant brain getting “imprinted” with TV as mommy (see Lorenz, 1969 on imprinting). Television, in synergy with convergent DVD and online media, becomes the source for instant, effortless, gratification, a perfect setup for nag factoring / relationship mining to follow.

The two weights over pulley metaphor casts doubt on the, not a second thought, equating of goodness with accelerating intensity of media to brain input. As the incoming stimulation escalates, the recipient does not remain unchanged and what changes do occur are not necessarily for the better. If true, what the proposed metaphor is saying is that if it takes more and more input to hook the consumer, as with an addictive drug, something in that consumer is going down. Although their study is a work in progress, Christakis et al., report that “early television exposure is associated with attentional problems [specifically attention-deficit/hyperactivity disorder, ADHD] at age 7.” They recommend that “efforts to limit television viewing in early childhood may be warranted, and additional research is needed” (Christakis, et al., 2004). In particular, the authors note this:

It is widely known that the newborn brain continues to develop rapidly through the first few years of life and that considerable plasticity exists
during this period. Considerable evidence also exists that environmental exposures, including types and degrees of stimulation, affect the number and the density of neuronal synapses. The types and intensity of visual and auditory experiences that children have early in life therefore may have profound influences on brain development.

In contrast to the pace with which real life unfolds and is experienced by young children, television can portray rapidly changing images, scenery, and events. It can be overstimulating yet extremely interesting. This has led some to theorize that television may shorten children’s attention spans. Others have speculated that is may lead to ADHD…[and] that television viewing reduces reading in later ages and self-reported levels of concentration. (Christakis, et al., 2004)

If the hypothesis of Christakis, et al., is right, the rising weight of televised input to the infant brain is being compensated by the falling weight of shortened attention spans later in childhood, which, arguably in some, is pushed over the genetically predisposed tipping point to ADHD. The rope linking the rising to falling, as per Walsh, is the young brain being exposed to energy saving shortcuts. The TV, like the tooting locomotive, does the work that the child’s brain, with parental help, once had to do itself.

**GAMER’S TOLL**

Children, tweens (ages 6-11 in the marketing world), and teens, today would be bored stiff by amusements that once held the attention of previous generations. Recent studies lament the fact that reading for entertainment, despite come and gone Harry Potter blips, is going down and down (see NEA report “Reading at Risk: A Survey of Literary Reading in America,” 2004 and its follow-up report “To Read or Not To Read: A question of National Consequence,” 2007). Why? Well books, like do-nothing wooden toy trucks, just sit there with words on pages. How can books compete with video games, as in the recently released super hot seller, super graphically violent, *Grand Theft Auto IV* (3.6 million copies sold on the first day out, $500 million in sales in the first week)? Yes, the latest and last in the Potter phenomenon sold 8.3 million copies in the U.S. on the first day after it went on sale. So maybe books can compete with video games? Or maybe the crowd reading Potter is not the same crowd craving to play GTA IV? Or maybe their soaring successes, like television itself, in similar, yet different, ways tap into something deep seated like the rope wrapped around pulley connecting the one heavier and one lighter weights: they pull the reader/player/viewer in – they hook.

**SYMBIONT NOT PREDATOR?**

There are some, especially, but not only, on the marketing side of the equation, who would argue that the model I’m proposing here is all wrong. The product/media torrent pouring into young brains is empowering them, the technology is not a predator, it is a symbiont. It feeds us, not on us. We rise up with the technics. When products eliminate the need for personal effort, mental or physical, they free us up to pay attention, to exert
ourselves on the things we choose, because we want to not because we have to. The title of Steven Johnson’s well celebrated book, *Everything Bad Is Good For You: How Today’s Popular Culture Is Actually Making Us Smarter*, captures the message of empowerment thru media. Television, according to Johnson, isn’t dumbing us down, it’s smartening us up. In case you haven’t noticed, program series like *ER* or *The Sopranos*, or the popular math wiz celebrating FBI series, *Numb3rs*, are far more complex and multithreaded than series of earlier generations like *Dragnet*, or *Gunsmoke*, or *Starsky and Hutch*, or even *Dallas*. Video games, by tapping into the brain’s natural reward circuits, brilliantly “manage to get kids to learn without realizing that they’re learning” (Johnson, 2005, 34).

**BLESSINGS UNINTENDED**

There’s something to be said for Johnson’s case. The ways media, TV, video games, toys, best selling, can’t put it down, novels, whatever, motivate mental, physical, or social effort, in those ways we and our kids rise up with whatever’s producing the incoming stimulation. Edward Tenner, in his insightful, *Why Things Bite Back: Technology and the Revenge of Unintended Consequences*, would call the benefits Johnson is pointing out, “reverse revenge effects” as in rare animals thriving in former weapons arsenals, or superfund sites, “because artillery shells and toxic wastes have kept people out” (Tenner, 1996, 10).

Unfortunately, these unintended blessings are just that, unintended. The selling point is not motivation to effort, it is the elimination of effort. Making it easy, or at least easier. Why is the GTA series such a hit? Answer, because solution by violence, especially when graphic, sex, bad guys, and hookers thrown in, is magnetic. Easy to get hooked and stay hooked. Multithreaded TV series draws, keeps the viewer off balance, addicted to wanting to find out what’s going to happen to whom and when. *Numb3rs* incorporates cool sounding theories for locating and catching perps. Bayesian probability, is a for instance. Odds are the bulk of the audience is clueless as to what exactly Bayesian probability is, but that doesn’t matter. It sounds brilliant. The viewer is flattered by being privy to math magic bad guy catching stuff. And yes, edutaining programs for tots does impart some edu with the taining.

But if, on balance, despite the sprinkling of reverse revenge in the incoming blitz, the 2nd Law weights linked over pulley metaphor holds water, what it tells us is that the sum total of losing it for not using it exceeds, conceivably, and worriedly, far exceeds, the pluses. Television may, in some ways be making us smarter, but since most viewers don’t turn on the TV to work harder, but to let those on the other side of the screen work like hell to grab and hold our increasingly fleeting attention, the scales of the medium are tilting ever more precipitously towards dumb and dumber (Jacoby, 2008; Barber, 2007). Yes, video games do improve gamer skills, hand eye coordination, rapid problem solving, and that’s good. The downside, not even considering the central ethos of violence as solution of choice with possible real world, tipping point, consequences, is all the things getting neither attention nor effort, physical, mental, and social, because the gamer is hooked for 40 to 100 hours playing just this one game; a downside, that for a small minority of
online gamers has actually resulted in death through neglect of basic requirements for life like eating and drinking (BBC NEWS, 2005).

CONCLUSION

The cannibalizing of childhood’s future is a systems problem with roots in the way the 2nd Law of Thermodynamics works. If you’re going to concentrate order, and the power that order grants, in a system, compensating dissipation must accrue somewhere in the environment of that system. While it can be argued that the accelerating power in all forms of technology driven media, including the increasingly fine tuned sophistication of marketing techniques, is being paid for by the consumption of food as proxy for fusion in the sun, the problem with this argument lies in the sheer and escalating rates of concentration. Just as the extremely rapid, irreversible, consumption of fossil fuels as concentrated solar energy formed over millions of years has allowed human industry to proceed at a pace not possible otherwise, the pace of focusing power in industrialized media, including the media impinging on childhood, demands compensation from other than food sources. Found in the environment of media, as a system, is the child. The compensation is the mining of childhood.

The dissipative mechanism we propose lies in the industrialized capitalizing on the deep seated, once survival enabling, but now out of whack in a technology transformed world, tendency to seek out shortcuts, to take paths of least effort, paths that reduce or eliminate the pain of effort. Since effort is our primary volitional means of opposing the universal trend towards swelling entropy, summed over the growing totality of effort being removed, our children, with mounting evidence of physical, mental, and social harm, are being served up as the sacrificial lambs of the soaring techno-industrial order.

The simple metaphor I’ve proposed of two weights linked over a pulley by a least effort rope, while for sure lacking in nuance, offers an image that can begin to help restore order where it belongs, in children, childhood, families, and non-virtual communities. The service the metaphor offers is that it raises up to the level of critical thought what normally lies below. If the falling weight, representing the ongoing loss of potential, is lightened to the point where the direction of pulley rotation is reversed, the exploiters will have to put more effort into a new business model, one that keeps its hands off children.

How can the pulley’s direction of rotation be reversed? The answer is simple, but real world implementation, not so, because it requires consciously avoiding opportunistic shortcuts. As in choosing to climb steps instead of taking the escalator, or not going round and round a parking lot to find a spot that requires the least walking to a door, it requires putting in more effort than our jerking knees, tell us is absolutely necessary. It requires recognizing Gresham’s Law of Child Activity and reversing the expectation that toys and technology do more and more. The answer is to inject effort, mental, physical, and social, back into childhood’s future.
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ADAPTING BANATHY’S SYSTEMS VIEW OF EDUCATION TO A SYSTEMS VIEW OF HUMAN SYSTEMS

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ABSTRACT

While Troncale’s System of System Processes (SSP) lists over eighty processes found in complex systems throughout nature, most systems workers are familiar with and apply a fraction of that number. Although knowledge of all eighty processes is not be necessary for a systems view, familiarity with most of the processes and their interactions should be a prerequisite for claiming expertise. In A Systems View of Education, Banathy described concepts and processes of human activity systems generally, and educational systems more specifically. He then asked readers to apply the concepts and processes to their particular systems. He took readers through three models of a system: the system-environment model, the function/structure model, and the process model. A comparison of A Systems View of Education with the SSP led to six suggestions for adapting and updating the rubric to general and specific natural and human systems: (1) Rename the “process model” to the “development model” or “change model.” (2) Add and/or emphasize development, hierarchy, networks, and chaos/attractors. (3) Reframe abstract, philosophical concepts like beauty, good, plenty, and truth into systems functions and processes. (4) Add the primary drives and physiological functions of human systems. (5) Articulate consciousness, cognition, and emotion as functions and series of processes. To more fully develop this rubric, a comparison to more recent systems texts is in order. Findings from fields as diverse as neuroscience, social and evolutionary psychology, and business management can provide further insight and examples. Finally, determining what is important for developing a beginning systems view and what should be included in later courses may be best discovered by offering the course and then determining with participants what is helpful and what needs revision.

Keywords: systems processes, isomorphies, systems education, human systems, consciousness, systems development, system of systems processes

INTRODUCTION

While Troncale’s (2007) System of System Processes (SSP) includes over eighty processes found in complex systems throughout nature, most systems workers are familiar with and apply a fraction of that number. Most researchers are concerned with modeling specific processes for application in their particular fields. Networks and power
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laws; evolution and adaptation; cycles, oscillations and symmetry; and chaos and attractors are a few of the groupings.

Although knowledge of all eighty processes is not be necessary for a systems view, familiarity with most of the processes and their interactions will probably be a prerequisite for claiming systems expertise in the future. With the increasing use of systems terms and processes in science and business literature, a basic, nonmathematical overview course for undergraduates and for those unfamiliar with systems concepts and theory is in order.

In *A Systems View of Education*, Banathy (1992), an educator, developed a three-model approach to developing a systems view of human activity systems generally and then educational systems more specifically. He first contrasted the industrial worldview with the systems worldview and then described his three models or “lenses.” The system-environment model shows a “bird’s eye” view of the system interacting with its environment. The structure/function model shows a still picture of the system at a particular moment. The process model shows a moving picture of the system adapting and evolving through time. In fifty exercises scattered throughout the book, readers are asked to apply the concepts and processes to their particular educational systems. Banathy used the text as the basic curriculum for his introductory systems classes at Saybrook Graduate School, and continued to write about human systems design and societal evolution.

I have applied the three-model approach to develop a systems view of the self, or subjective experience, and found it to be a useful framework (Rasmussen, 2000, 2004, 2006). However, Banathy’s later work, Troncale’s system of systems processes (SSP), and new work in hierarchies, networks, chaos theory, critical systems and more demands a considerable revamping of the content of the models.

**INITIAL SUGGESTIONS FOR ADAPTATION**

Comparing Troncale’s list of systems processes to those covered in Banathy’s three-models reveals those processes not included. Although all are not necessary for a beginning overview, many processes have become more generally recognized over the last fifteen years.
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Table 1. A comparison of Troncale’s list of systems processes with processes found in Banathy’s three models and suggested addition

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Adapting Banathy’s View

The following are initial and broad suggestions for adapting and updating Banathy’s rubric for application to both general and specific human systems:

1. Rename the “process model” to the “development model” or “change model.”

Because the term “process” is used to describe isomorphies found in all three models, the label “process model” is awkward. In his process model, Banathy focuses on input, transformation, and output processes, and then guidance and management of each. With his focus on education in the 1980s, he was concerned about entrenched bureaucracies. Although the bureaucracies still exist, the Internet and online communities offer people different experiences and a “feel” for systems that wasn’t as prevalent twenty years ago. Processes of development and networks lend a richer view of systems moving through time that are applicable and useful now.

2. Add and/or emphasize development, hierarchy, networks, and chaos/attractors.

Development: In his first chapter on general introductory concepts, Banathy compares five “systems types” that range from relatively closed, unchanging, and controlled to relatively open and continually evolving. The same systems types can be shown to exist in various human systems as developmental levels, each level demonstrating an increasing capacity to integrate and deal with complexity and co-evolve with environments (Rasmussen, 2006).

Hierarchy: Although Banathy explains embeddedness and the relationship among systems, subsystems, and suprasystems, hierarchy is referred to only once. A basic 1996 systems skill is to place the observed system within its systemic context and then understand the general dynamics and relationships among the surrounding levels. The system of investigation, N, interacts with its subsystems, N-1, N-2,. . . and with the systems in which exists, N+1, N+2, . . . N-1 is the level of explanation for N, while N+1 is the level of significance of behavior of N (Au & Allen, 1996). In human systems
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generally, for example, a marriage, N-1 will be the individuals and N+1 could be the community in which a marriage exists. Hierarchy as a process is also demonstrated in hierarchical levels of human development.

Networks: A basic understanding of networks, whether neural, cognitive, or social, is required for even an introductory systems view. How they form, how they are maintained and grow, and their interrelationship with development and hierarchy lends to the understanding of whole systems (Barabasi, 2003; Troncale, 2004-2007).

Chaos/attractors: In brains and cultures, extremely complex networks form attractors, and attractors disintegrate into chaos and form up again (Perkovsky, 2007). From a mechanical view, chaos is breakdown. From a systems view, chaos may represent the temporary reorganization to a more complex and integrated level of systemic development. In human systems, from individuals to the global, this process is experienced but poorly understood.

3. Reframe abstract, philosophical concepts into systems functions and processes.

Banathy describes fundamental “purposes” of human activity systems from the Greeks: beauty, truth, plenty, and good. These can be reframed in terms of function and process.

One approach comes from the explanatory level of whole brain activity. As described above, sensory information is continually entering the brain and forming into masses of networks at different brain areas and levels, and then emerging in the whole brain as “attractors.” These attractors organize, break down into chaos, and reform four to five times per second in what Freeman (2000) describes as being like “cinematic frames.” When the attractors are highly orderly, they reflect familiar patterns that evoke positive emotions. This same dynamic operates not only in brains and individuals but also in whole cultures (Petrovsky, 2007).

**Beauty** can be framed as orderly patterns that result in good feelings and openness. **Truth** is the clear flow of information that reflects the world as it is. The pattern is “in sync” with experience in the world. **Good** can be framed as the clear flow of information and matter/energy toward the increased order, integration, and development of systems and their systemic environments. **Plenty** is the flow of resources toward the further integration and development of a system.

Banathy lists seven “dimensions of purpose” required for a human system to operate as a functional whole. He describes them as interrelated and as a system of purposes. Take Banathy’s reasoning a step or two farther and these dimensions of purpose can be framed as flows of information and matter/energy that support the increasing integrity and development of the system, its subsystems, and its systemic environment:

**Social action** is flows of information and matter/energy—behavior—from the system that strengthens the systemic environment. $N \rightarrow N+2, N+3$
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**Economics** quantifies the flows of resources (information and matter/resources) through the system and its systemic environment \( N \leftrightarrow N+1 \leftrightarrow N+2 \ldots \)

**Morals and ethics** represent actions and behaviors directed toward the increased well-being of the system and its systemic environment. \( N \rightarrow N+1 \rightarrow N+2 \rightarrow N+3 \)

**Health** is clear flow of information and energy/matter through the system that results in growth, development, functioning of the system. \( N \leftrightarrow N-1 \leftrightarrow N-2 \leftrightarrow N-3 \)

**Education and learning** is the flow of information that assures the growth and development of the system and its capacity to adapt to or co-evolve with its environment.

\[ N + 1, N+2, N+3 \rightarrow N \leftrightarrow N-1 \]

**Esthetics**—great design, beauty, art—are openness and order that allow for and increase flows of information and matter/energy through and among systems.

**Governance and guidance** refer to control of the direction of flows and the openness/closure of flows. Governance involves feedback systems that regulate system.

**Science and technology** are extensions of system’s capacity to function. They increase human capacity to attain all of the above purposes.

4. Add the primary drives and physiological functions of human systems.

A function of human activity and meeting basic needs, and can be described within Banathy’s dimensions of purpose. Maybe because his focus was on educational and business systems, Banathy didn’t focus on the basic needs for air, water, shelter, etc. and the basic instincts that underlie and drive human behavior. Interesting to note, Perlovsky (2007), a neuroscientist and engineer, describes what he has coined as the “knowledge instinct:” “To satisfy any instinctual need—for food, survival, and procreation—first and foremost we need to understand what’s going on around us. The knowledge instinct is an inborn mechanism in our minds, an instinctual drive for cognition which compels us to constantly improve our knowledge of the world (p. 73).” He extrapolates that drive to whole cultures.

5. Articulate consciousness, cognition, and emotion as functions and series of processes.

Banathy doesn’t deal directly with the concepts of consciousness, cognition, and emotion in the three models. Recent research from neuroscience offers explanations and models that can be reframed as interactions of processes.

Human systems, whether individuals or nations, operate at different levels of consciousness that are associated with boundary conditions of openness and closure, the capacity to integrate and adapt knowledge and information, the capacity to direct flows of information and matter/energy in constructive directions, and the capacity to understand and deal with increasing complexity. These are the same processes described in Banathy’s
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systems types and can be framed as developmental levels within the change and development model.

Consciousness is also associated with our “second nature,” our capacity to not only exist within but also to imagine and create systems together (Edelman, 2007). Design is a uniquely human activity. Although it was a primary theme in his later books, Banathy briefly touched on it in his final chapter on activation of the models. Design can be included as a function in the structure/function model and further described in the process or change model.

Emotion operates as a part of a regulatory function in individuals and can be extended to all human systems. Love and peace can be framed as the feelings (internal signals) and expressions (external signals) triggered by the open flow of information and matter/energy between and among people that results in the bonds that from social groups. Fear and anger are associated with closure in response to threat (Davidson, 1993). A function of consciousness is to open in the face of threat in order to see more clearly and respond.

FURTHER RESEARCH

While Banathy’s three-model approach offers a valuable framework, the focus on human systems generally, rather than on educational systems specifically, demands significant additions and revisions. To more fully develop this rubric, a comparison to other, more recent systems texts is needed. Findings from fields as diverse as neuroscience, social and evolutionary psychology, and business management can provide further insight and examples. Finally, determining what is important for developing a beginning systems view and what should be included in more advanced courses will be an interesting challenge that may be best determined through action research, by offering the course and then determining with participants what is helpful and what will need to be revised.

REFERENCES

Adapting Banathy’s View


ARE ECOSYSTEMS ALIVE?

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ABSTRACT
A system is a group of interacting components in which the nature of the interactions maintains the situation as an interactive group for some relevant amount of time. Organisms are living systems in which a complex of subsystems, biological cellular-maintenance metabolism, contained and protected by an outer membrane, continuously maintains the character and dynamic nature of the system. An ecosystem is a system composed of living organisms and their abiotic environment.

While it is observationally evident that the abiotic component of an ecosystem contains the biotic component, the question has been raised whether an ecosystem is also a living system, like unicellular and multicellular organisms. An accurate, rigorous answer requires a realist approach that is not based on subjectivity, postulate, hypothesis, or theory, but rather on consideration of the intrinsic qualities of (a) living systems and (b) systems with living systems as components. Because this is a question about the nature of these systems, this is a problem for general systems science.

Unicellular organisms, such as amoebas and paramecia, are living systems—they are alive. Using a single individual unicellular organism as a baseline example of a living system, the discussion follows a development of increasing complexity of relation and hierarchy from two such individuals in a simple group, through a few stages of system development to the level of an ecosystem. Along the way are noted the factors that prompt that development, and whether those factors or the emergent relations or hierarchic levels confer life on the successive situations. It is a series of stages of increasing complexity of systems with living systems as components. The idea, if ecosystems are alive as ecosystems, at the hierarchic level of ecosystem, then where do the factors that make them so come into play, somewhere in the development of systems leading up to the level of ecosystem, or only at the moment of emergence for an ecosystem?

With the results of this investigative process in hand, the discussion turns to questions concerning the origin of the idea that ecosystems are alive, that they are living systems. Here general systems theory comes into play. There are specific patterns of organization of material structure and process (system principles, isomorphies, etc.) that occur in diverse situations—such as at multiple levels of the hierarchic organization of material reality—that those patterns play specific roles in the intrinsic nature of those situations, roles that are consequences of the intrinsic nature of each pattern of organization. General systems studies these patterns of organization, discovering (1) which patterns play these general roles, (2) where they occur, (3) how they influence the nature of the situations in which they occur, and (4) how and why they differ from one situation to another. Once these general patterns of organization are recognized and understood, they can be used as intellectual tools to enhance the understanding of various situations. This is systems thinking, and it is necessary in order to achieve an understanding of whether an ecosystem is alive or not, and why.

Keywords: ecosystems; hierarchy; living systems; systems thinking; general systems
Are Ecosystems Alive?

INTRODUCTION

“What distinguishes an ecosystem from an organism?” “Are ecosystems ‘alive’ or do they just contain life?” These are two of the questions listed for the 2008 International Society for the Systems Sciences Annual Meeting. The answers to these questions are provided by realist philosophy and general systems science.

Realist philosophy has two roles. First it strives for accurate knowledge and understanding of the intrinsic nature of reality, of that which exists. Second, realist philosophy sets the rules for science. The purpose of science is to provide accurate knowledge about the intrinsic nature of reality. Realist philosophy figures out how to do that, and passes judgment on the results of science. For example it is realist philosophy that points out that it is observation, with all its various methodologies, that leads to accurate knowledge. Realist philosophy additionally points out the foundational and universal necessity of objectivity in the pursuit of accurate knowledge and understanding. Realist philosophy examines the procedures by which an item of proposed knowledge has been found, and compares that proposed knowledge with what is already known.

General systems science is a science of comparison. There are specific patterns of organization of material structure and process that occur in diverse situations—such as at multiple levels of the hierarchic organization of material reality—where those patterns play specific roles in the intrinsic nature of those situations, roles that are consequences of the intrinsic nature of each pattern of organization. General systems studies these patterns of organization, discovering 1) which patterns play these general roles, (2) where they occur, (3) how they influence the nature of the situations in which they occur, and (4) how and why they differ from one situation to another.

So, “Are ecosystems ‘alive’ or do they just contain life?” To distinguish living systems, such as unicellular and multicellular organisms, from systems that have living systems as components, such as ecosystems, it is necessary to compare the intrinsic patterns of organization of organisms and ecosystems to see in what way they are similar and in what way they are different. This is the work of general systems science.

Two things that influence the nature and the role of a pattern of organization in any particular situation are (a) factor development, and (b) the context the situation provides for the existence there of that pattern. A factor is something that exists in a situation and plays a role there. For example, any particular pattern of organization of material structure and process that occurs in a situation is a factor of that situation. Various situations provide different contexts for factors because (a) they can differ in what they are made of, and (b) they contain different mixes of additional factors. Because it is the intrinsic qualities of a component that determine the nature of the relations it can have with other components, what components occur in a situation determine what kinds of relations can occur there, and thus the manner in which a pattern can exist in that situation.

With factor development, a factor occurs in simple form and plays simple roles in simple situations where few other factors are also playing roles, but occurs in more complex form and can play more complex roles in situations where larger numbers of other factors are playing a greater diversity of roles. For example, when a particular pattern of organization occurs at two levels of a hierarchical situation, there will be fewer hierarchical levels that constitute the structure of the pattern of organization at the lower level and a greater number of levels constituting the structure of the pattern at the higher level. At the higher level there will be all the levels that constitute the lower level, plus all the intervening levels. Those intervening levels add complexity to the intrinsic nature of the higher level case of the
pattern of organization. That factor, the pattern of organization, occurs there in a more complex, developed form.

A group of interrelating factors constitutes a situation, and situations develop in multiple ways. A pattern of relations of particular significance in situation development is that the nature of what goes before determines the nature of what follows. Following the development of a factor or of a situation provides understanding of how and why a factor or situation comes into existence, and why they have their specific intrinsic qualities. Living systems and systems with living systems as components are developmentally related. Organisms are components of ecosystems, ecosystems are hierarchically above organisms, and ecosystems are more complex than organisms. There are developmental relations of hierarchy and complexity. What distinguishes organisms from ecosystems are factors of development.

DEVELOPMENT OF LIVING SYSTEMS AND SYSTEMS WITH LIVING COMPONENTS

The developmental path that will be followed begins with a unicellular organism, a single free-living cell, and then looks at various stages leading up to the level of an ecosystem. The most obvious factor that will be found that distinguishes living systems from systems with living components is that living systems are coherent systems, systems in which the components are coherently attached to one another, while the other systems that will be looked at along the way are noncoherent systems, systems in which the components are not coherently attached. Less obvious will be the intrinsic nature of various factors that play roles in all theses stages, but that develop along the way, thereby playing their roles in different ways at various stages, and thus having different effects on the nature of the situations in which they occur at each of the successive stages.

All known living systems are extremely complex with diverse components and multiple subsystems. Life is a complex of structure and process which varies tremendously from the simplest forms of living beings to the most complex forms. It turns out that very few of these factors are required to be present in an individual living being all the time. Even fewer such factors universally distinguish something that is alive from something that is not alive. It appears that an exterior membrane containing a cell-system maintenance-metabolism continuing its diverse processes in a normal manner are the basic requirements that must be present for a system to be alive. If the cell maintenance processes stop, all other processes stop, and all levels of life die, from the cellular level to the organism level, with consequent virtually complete disorganization of the living system.

How these requirements occur in the stages from a unicellular organism to an ecosystem will be looked at in this sequence: (1) a single free-living cell (an amoeba), (2) a simple group of free-living cells, (3) a system with interacting free-living cells, (4) a system with interbreeding unicellular organisms (paramecia), (5) a system of interacting species, and (6) an ecosystem.

A Free-living Unicellular Organism

An amoeba, making its way across the field of view of the microscope, is alive. It is a living system, comprised of diverse components interrelating in complexly networked hierarchies and processes. Closer magnification reveals a flow within, a number of structures, organelles, being moved about. This one-celled creature’s metabolism takes place in the fluid cytosol of that flow, and also on the surface of and inside those structures. There is
also a cell membrane that keeps the contents of the cell together and prevents it from being lost to the surrounding medium. Thus, the amoeba has the basic requirements of a living system.

Now look at the creature more generally, as a whole. It is a single living cell. Its outer membrane confines all its components into a single unit. In order to do that, the molecules of the cell membrane must stick together. They must cohere with a bond of sufficient strength to maintain the integrity of the cell. Within the cell there are other such coherent relations between molecules, for example, those that maintain the structure of the various organelles. However, throughout the cell there are multitudes of components that are not coherently bonded, the molecules of the cytosol and all the items carried about by it, and many others within the organelles.

**Stage 1**

![Diagram]

- **Living coherent system**
- **Unicellular organism**
- Cell divides with separation of new units
- Creates noncoherent group of living units

**Figure 1.** The amoeba, as a living system, as a contained compound system, is a coherent system.

When units of matter join together in a coherent manner they form a coherent system, such as a rock, a drop of water, or a seed—individual units. When units of matter interrelate without sticking together they form a noncoherent system such as the atmosphere, a flock of birds, or the cytosol and the items within it—groups of units. The amoeba is a compound system in that its components have both coherent and noncoherent relations, with the latter contained by the former. A coherently contained compound system, as a whole, exists in the form of an individual unit—a compound system occurring, overall, in the form of a coherent system, a developed form of coherent system. The amoeba is alive as a free-living unicellular organism, as a living system, as a contained compound system—as a coherent system (Figure 1).

**Simple Group of Free-living Unicellular Organisms**

When a cell divides there are then two cells together. This situation constitutes a simple group, wherein units occur in proximity to one another but do not interact—a noncoherent group (Figure 2). Because there is no interaction, a simple group is not a system. The situation is a noncoherent group composed of two coherent systems. The coherent systems are alive, but the situation at the level of the simple noncoherent group cannot be alive, cannot be a living system, because it is not a system at all. Even though at the hierarchic level of the components the units are individually alive, at the hierarchic level of the whole, it is no more than a nonliving group.
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Stage 2
Nonliving group of two noncoherent coherent systems

Unicellular organism

Living units interrelate

Group becomes noncoherent system

Figure 2. Two cells together constitute a simple group, wherein units occur in proximity to one another but do not interact. This is a noncoherent group composed of two coherent systems.

System of Interacting Free-Living Unicellular Organisms

When the cells of a simple group begin to interact, bumping into one another and competing for space and food, the situation becomes a simple system. Because it is composed of individual living organisms, it is a social system (Figure 3). A social system is a pattern of organization, and like virtually all factors, it develops, beginning here in simple form with simple organisms, and developing up to the stages and complexities of human societies, and then on to multispecies communities. A social system is a hierarchic level above an organism. Can that higher level be said to be alive? Is a social system a living system? Does the mere quality of being a system constitute the attainment of being alive?

Stage 3
Nonliving noncoherent system composed of coherent systems

Unicellular organism
Coherent system

Interaction

Unicellular organism
Coherent system

Population grows
Living units exchange genetic material

A noncoherent system composed of interacting living systems
Social System
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Figure 3. When the cells of a simple group begin to interact, bumping into one another and competing for space and food, the situation becomes a simple social system.

The situation is a noncoherent system composed of coherent systems. There is life at the hierarchic level of the components, the individual living cells. They have cell maintenance metabolism and a coherent membrane that keeps the parts together. However, the types of interactions that take place between the cells, at the system process level, do not constitute system maintenance relations. Collisions and competitions are more likely to disperse the members of the group and result in the disintegration of the system character of the situation. There is no membrane or any sort of intrinsic barrier to keep the parts together. The type of interactions and the qualities of the system at the level of the noncoherent relations between these cells are not the type of relations and qualities that together constitute a living system. The situation at the level of noncoherent system composed of simply-interacting living units is not alive. A social system at this stage of development is not a living system, but rather a system composed of living systems.

System of Interbreeding Unicellular Organisms

A system is a group of interacting components in which the nature of the interactions maintains the situation as an interactive group for some relevant amount of time. A social system is a system with living components, the behaviour of which maintains the situation as a system. At the previous stage, the interactive relations of competition for space and food established the situation as a social system in only a minimal sort of way. At this stage, the interbreeding relation is a mutually enhancing cooperative encounter that plays a distinct role in maintaining the situation as a system. As with the prior stage, the situation here is a noncoherent system composed of coherent systems (Figure 4).

Interbreeding involves an exchange of genetic material, and with unicellular organisms this occurs by way of processes collectively called conjugation. While both amoebas and paramecia reproduce by way of cell division, for transfer of genetic material it is necessary to switch attention away from the group of amoebas to a pair of nearby paramecia.
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**Stage 4**

Nonliving noncoherent system composed of interbreeding coherent systems

![Diagram](image)

Unicellular organism
Coherent system

Conjugation

Unicellular organism
Coherent system

Noncoherent system composed of interbreeding living systems

Social System

Immigration of Species

Additional species arrive and form community

Evolution of new species

Reproduction

**Figure 4. A noncoherent social system composed of interbreeding living units—an interbreeding population system.**

Conjugation, in which the paramecia exchange DNA, is an encounter between two individuals, a minimal social event. Afterward they each go their own way, and the social situation would seem to disappear. However, over time and under appropriate circumstances, the two paramecia, and their progeny through division, conjugate with various other members of the local population. The result is the transfer and distribution of various genes through the population and the development of a gene pool. The group of individual paramecia and the set of genes they transfer through the population constitutes a social system, wherein the interactive behaviour of the component living subsystems maintains the nature of the larger system.

In cell maintenance metabolism, the component subsystems interact in a manner that maintains the cell system as a whole. Cell maintenance metabolism confers life on the cell. Does conjugation, the transfer of DNA among a group, which creates a dynamic gene pool, confer the quality of life on the social-system-level group of living components? A review of the relation of coherence and noncoherence in this sequence of stages can provide the answer.

In the first stage (a single unicellular organism) (Figure 1), noncoherence plays a required role in cell maintenance metabolism making it possible for the various components to move about and engage in sequences of reactions. Coherence plays a role in the structure of organelles and another role in the cell membrane in keeping all the components of the living system interactively together. The first stage is a compound system, which due to the coherent membrane occurs as a whole in the form of a single unit coherent system.
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The second stage (Figure 2), a group of organisms, is a two level hierarchy. At the first level, that of the living system organism, the roles of noncoherence and coherence are as just described for the first stage. At the second level, that of the group, there is no role for coherence. It is a completely noncoherent situation in that there is no interaction at all, and thus no role for system, and no role for living systems relations at the second level. The second stage is a group of two noncoherent coherent systems.

The third stage (Figure 3), also a two level hierarchy, is a rudimentary system because there is interaction between the components. At the lower level are the coherent living systems components. At the upper level the components are noncoherent but have interactions. Because there is no outer membrane keeping the noncoherent components of the system together, those components can easily disperse, disintegrating the system and any possibility of there to be a living system. The third stage is a rudimentary system of two (or more) noncoherent coherent systems.

The fourth stage (Figure 4), again a two level hierarchy, has definite simple system interactions. There are the lower level coherent living system components. The upper level again consists of noncoherent components. While the interactions at the this level establish an ongoing system, the noncoherence of the components allows the frequency of the encounters to be so sporadic, so dispersed, that the situation is only barely an ongoing system, far too simple and inconsistent to confer a living system status for this case. The fourth stage is a simple system of noncoherent coherent systems.

So far, noncoherence without an associated role for coherence has precluded the possibility of there being a living system at the second hierarchic level, the level of the system as a whole.

System of Interacting Unicellular Species

The next stage is an ecological community system (Figure 5). Here the components of the system are the populations of the organisms, the species populations that interact with one another. The community within an ecosystem is composed of all the living organisms that are living there. The interactions that take place are numerous, diverse, and complex, such as competition between species for resources, ecological succession, predation, and mutualism. Community dynamics can follow trends of change or establish various homeostatic conditions. A great many general patterns of structure and process occur in community dynamics, making this situation the first in this sequence of stages to have sufficient complexity for a possible claim to actually be a living system.
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Stage 5
Nonliving noncoherent system composed of noncoherent species systems composed of coherent systems

A species
Unicellular organism
Coherent system
Conjugation

Another species
Unicellular organism
Coherent system

Figure 5. Nonliving noncoherent ecological community system composed of noncoherent nonliving interacting species population systems composed of coherent living interbreeding individual organisms.

The situation is now a three level hierarchy. The lowest level is composed of all the individual organisms of all the species populations—individual coherent living systems. At the second level are the interacting and interbreeding populations of the various species—systems of interacting noncoherent components that do not at this hierarchic level constitute living systems. At the third level are the interrelations between species. Because species exist as the individuals of the species, the interactions of one species with another occur by way of interactions between individuals. The cumulative encounters establish the state of the group, the species population, in the local community of species. The situation is a noncoherent system (the community) composed of noncoherent systems (species populations) composed of coherent systems (individual creatures).

As with the previous noncoherent systems back to noncoherent group, there is no system outer barrier that keeps the interacting noncoherent subsystems together. It turns out, however, that established ecological communities tend to remain in place, despite what is probably a continuous dispersal of individuals from the periphery. The lack of a containing barrier in this case does not seem to completely preclude the possibility of this third level situation from being a living system.

As far as is known, life originated on earth only once. Since then, all life has been one, several billion year old, bifurcating cascade of reproductively linked organisms. Throughout all these unbroken diversifying chains of living beings, life has been based on the cellular
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pattern of organization, both with unicellular and multicellular organisms. As far as is known there has never been any other form of life than that based on the cell.

For the interactions between species at the community level to constitute a living system would be the equivalent of the re-emergence of life at a higher hierarchic level. It would be a new creation of life, a truly new creation of life because it would not be reproductively derived, not genetically derived—not a part of that great multibillion year old cascade of reproductively linked individuals. It would be creation of life by way of combinatorial enhancement, the emergence of a living system through the creation and combination of the particular set of general patterns of organization that together constitute a living system (what the artificial life researchers would like to achieve). While the emergence of life in cellular form has occurred only once, has anything like this combinatorial emergence ever happened before? Well, yes, it has, and this is why there has always been so much trouble with defining life—there are two distinct levels.

It appears that life probably originated at the cellular level, with a cell membrane there at the beginning to protect and contain the life processes. Thereafter, and on a number of different occasions, dividing cells did not separate and these situations eventually evolved into multicellular forms of life. Now, within a unicellular organism there are a variety of life processes and organelles that carry out those processes. There is a division of labor and cell machinery. The evolution of multicellular organisms is based in large part on the differentiation of the cells such that there occurs a division of labor, and the evolution of organs. Just as at the lower hierarchic level of individual cells there is cell maintenance metabolism, at the higher level there is multicellular organism maintenance physiology. Unicellular organisms are living systems, they are alive, and multicellular organisms are living systems, they also are alive. Because a multicellular organism is alive, as are the individual cells of which it is composed, there are two coexisting levels of living system, two levels of systems that are alive. Any definition of life must include both levels (there are differences).

If life can emerge at a higher level like this, can the level of ecological community achieve living system status? The answer requires a comparison of multicellular organism pattern of organization with that of ecological community. There are two outstanding features of distinction—system integration and the coherence/noncoherence aspect.

A remarkable feature of the complexity of cellular metabolism is the intricate integration of the subsystems. Of particular significance here are the roles of DNA and the subsystems that regulate gene expression, which constitutes a cell system control subsystem. The physiology of a multicellular organism is also tightly integrated, and again there are system control subsystems, for example, the endocrine and nervous subsystems. In both the unicellular and multicellular cases it is system maintenance that is the primary role of the subsystems and their interactions.

Compare that with the aspects of system maintenance integration of an ecological community. Despite an impressive complexity of interactions among the components of an ecological community, the actual system maintenance integration interactions are in no way close to those of organisms. The interactions between the species components of an ecological community are, for the most part, encounters involving competition and consumption, rather than relations that enhance system maintenance integration. That ecological communities are loosely integrated compared to unicellular maintenance metabolism and multicellular maintenance physiology is made clear by the absence at the species community level of subsystems that are specifically system control subsystems. Ecological community systems do not require for the maintenance of their structure and processes the role of a system control subsystem. They do not require for their existence all
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the qualities that are required for a living system. The presence of system control subsystems in the organism cases and the absence of this type of subsystem in the community level case show that these are two distinct kinds of systems. An ecological community is not a living system—it is not alive.

An additional point to note here is that all the living components of ecological communities are coherent systems with outer boundaries such as cell membranes and skin and exist as individual units, while the system at the community level, lacking a barrier boundary, exists as a noncoherent system. So far, the living systems are coherent systems and the nonliving systems are noncoherent systems.

Ecosystem

An ecosystem is a system composed of living organisms and their abiotic environment (Figure 6). Under natural conditions an ecosystem is usually an ecological community and the various factors of the place where it exists, the bedrock or mineral substrate, the medium such as atmosphere or water, and the energy that passes through. The abiotic components include for example weather, topography, drainage, mineral leaching and deposit, seasons, day and night, erosion and sedimentation, and fire. The abiotic components basically set the stage for the ecosystem, and the biotic components live on or in, use, adapt to, and to various degrees, modify the abiotic components.
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Stage 6
Nonliving noncoherent system composed of noncoherent species systems composed of coherent systems existing in an abiotic environment

Figure 6. An ecosystem—a nonliving noncoherent ecological system with great quantity and diversity of biotic and abiotic components and their interrelations.

This discussion is considering the relations between living systems and a series of systems with living systems as components. First there are all the individual living organisms, the only actual living components of an ecosystem. Then there is the two level hierarchy of organisms interacting and constituting a system, wherein the organisms are alive but the
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situation at the level of simple system or social system is not alive. And there is the three level hierarchy of organisms, species, and ecological community, wherein the situation at the level of community is not alive. With an additional level, the abiotic environment, does an ecosystem—composed of living systems and a great variety of nonliving factors, components, and subsystems—constitute a living system? Is it alive?

Two critical factors distinguishing ecological community systems from living systems were the lack of a system control subsystem and the lower degree of integration in the ecological community. As it turns out, the abiotic factors of an ecosystem do not provide that system with a system control subsystem. Furthermore, the kinds of relations between the organisms and wind, leaching, and slope of the land are not the same kinds of relations between the subsystems of living systems. While there is a tremendous amount of complexity, there is not the equivalent degree of integration within that complexity. Ecosystems, like community systems, are not the same kind of system as are living systems, although they are like community systems in that they are also noncoherent systems. Ecosystems are not living systems—they are not alive.

WHY ASK THIS QUESTION?

Ecology is the interrelations of organisms and their environment, both the abiotic and the biotic aspects. The environment, the organisms, and the interrelations constitute an ecosystem. The organisms are alive. The abiotic factors of the environment, sand, the shape of a river channel, night, are not alive. The question suggests that there might be some way in which the combination of the two types of components could be alive.

Ecosystems do not look like organisms. Organisms are coherent systems, while ecosystems are noncoherent systems. The integration of ecosystems is not like the integration of organisms. Organisms have system control subsystems, while ecosystems have no role for such a subsystem. Where, then, does the idea come from that these two foundationally distinct kinds of systems could both be living systems? Two possibilities come to mind. First is the anthropomorphic projection of the living quality of organisms onto closely integrated groups of organisms, such as beehives, ant colonies, ecological communities, and ecosystems. And second, there is in the field of systems/complexity a widespread inadequacy in depth and breath of actual understanding of the nature and application of general systems thinking. The result is the misapplication of general patterns of organization, general systems principles, or isomorphies to situations where they do not occur, and the misunderstanding of the intrinsic nature of these factors and the roles they play in situations where they do occur.

Projecting the Life Quality of Organisms onto Systems Composed of Organisms

When spending a great deal of time closely observing colonies of ants and wasps, there develops a sense of the close ties between individual members of these colonies, and from that, and the diversity of their activities, there develops a sense of integrated social closeness. The colony is a unit, an active, busy whole going about its business within its environment of grasses, stones, shrubs, and trees. All the evident components, the organisms, are alive. It is natural to think of all of them together as a situation of aliveness, a living situation.

When observing an ecosystem, a forest or a grassland, what is evident is the plants and animals. The abiotic environment is there, in many ways it is visible, but it is the environment, the context. Unless there is something dynamic, grand, or particularly interesting about the abiotic factors, the mind tends to focus on plants and animals, on the
ecological community aspect of the ecosystem. When observing such a community, seeing all the diverse interactions, and thinking about all that is going on there that is not immediately evident, there is again a sense of situation aliveness, the sense of a dynamic living situation.

An ant colony is a social system, a family level social system. In the organizational relation of components to the whole, it is a two level hierarchy, the living ant organisms, coherent systems, and the family social system, a noncoherent nonliving system. But there is more to insect colonies. There is almost always some artefact the insects have constructed—tunnels in the ground or in wood, nests made of various natural materials such as leaves sewn together with silk or the paper nests of hornets. These artefacts are components of the colony system, and when thinking about the colony as a living system these nonliving components are the context, the nest, or shelter of what is viewed as the living aspect of the situation. They get relegated to background, just as the abiotic aspects of the ecosystem. In both cases the mind gets distracted by the living components, and attributes to the group dynamic a feature, life, the required qualities of which do not actually exist there, at that hierarchic level of organization. The sense of situation aliveness, of a living situation, whether of a social system or an ecological community system dominating the view of an ecosystem, is a form of anthropomorphic projection. Anthropomorphism, in all its forms, is a nearly universal, subjective, human habit of mind, and a bane of accurate, objective observation and description.

Misunderstanding and Misapplication of General Patterns of Organization

From the beginning of general systems theory there has been the understanding that there are certain general patterns of organization that occur at various levels of the hierarchic organization of reality, and that additionally occur in diverse situations broadly across those levels. It was recognized that these generally occurring patterns of organization play roles in the situations in which they occur, and further, that they could be used to enhance understanding of those situations. To understand these general patterns in their diverse forms and roles, and to be able to use them as tools of analysis and further understanding is to think like a generalist.

From the beginning there was a problem. There were no generalists adept at finding these patterns, analysing, using, or teaching them. Everyone had been trained as specialists, worked within specialist paradigms, used specialist terminology to name and describe these general patterns—and the progress in general systems theory bogged down. Of the patterns that were identified, there occurred a failure to achieve deep understanding, and an equal failure to achieve the ability to traverse the breadth of modern knowledge, unifying that knowledge by using these patterns as a means of exploration and integration of understanding. The name general systems theory was abandoned by some, and the field was more fragmented—systems science, complexity science, chaos, fractals, and so on—than unified.

However, as the years went by there has always been a small core of people who would not let go of their understanding of the potential of general systems theory. Researchers recognizing the importance of systems understanding for the resolution of major world problems pushed forward the science of systems—analysing, diagramming, flow charting, simulating, and developing tools of analysis and of practical application.

Unfortunately, significant depth and breadth of understanding has seriously lagged behind. The result has been a widespread misunderstanding and misapplication of these general patterns of organization and the roles they play. And this is the other source of the question, “Are ecosystems alive?”
Are Ecosystems Alive?

One major impetus for the misunderstandings behind this question was the misapplication of general patterns of organization in James Miller’s living systems theory, where there are several noncoherent systems mislabelled as living systems (Miller, 1978). By mislabelling as living systems (a) the group, (b) the organization, (c) the society, and (d) the supranational system, the way was opened for researchers to wonder if there were other noncoherent systems with living systems as components that might also be considered as living systems. Once error is introduced it tends to lead to further error.

Scott Turner (2007) has analyzed processes that provide ventilation to the nest of the termite Macrotermes michaelseni. The above ground portion of the nest is an earthen mound with zones of porosity that allow a wind driven exchange of gases within the underground portion of the nest. The mound is a nonliving structural artefact that in physical interrelation with the wind establishes physical environmental conditions within the nest such that the termites can breathe.

Turner says, “... the mound’s principal function as an organ of colonial physiology: it is a wind-driven lung to ventilate the underground nest.” (2007, 134) This is anthropomorphism. Living lungs with their associated physiology as ventilation systems and nonliving artificial ventilation systems made of soil and driven by wind are different. Even though the factor, ventilation system, occurs in both cases, living organ and artificial soil mound, artificial ventilation systems are not lungs, they are not organs, and they do not have physiology. Both cases are ventilation systems, but of different kinds—different in what they are as ventilation systems.

The original anthropomorphism leads to further error. “One of life’s most striking attributes is the tendency of living agents to assemble into what we might call ‘organism-like’ entities: cells into tissues, tissues into organs, organs into organisms, or organisms into superorganisms.” (2007, 146) But there is no such thing as a superorganism composed of organisms. Following the development of Turner’s list of stages, the first three stages originate by way of development of coherent systems into more complex coherent systems. The last stage, however, originates by way of the development of a coherent system into a group of noncoherent individuals, a termite colony.

There are two primary problem areas where the approach to living systems theory was not adequate for a realistic theory. First, the theory did not incorporate sufficient understanding of factor development, and the consequences of that development for the roles of the factors in different situations. And second, there was not sufficient understanding of the significance of the difference between major developments and minor developments, that major developments should be expected to have major differences in consequences.

Anything that exists in a situation and plays a role there is a factor of that situation. When general patterns of organization occur in a situation and play roles there, they are factors of the situation. A fundamental and virtually universal characteristic of factors, including general patterns of organization, is that they develop, having simple form in simple situations and more complex form in more complex situations. A critically important point to understand about factor development is that as the factors occur in different form, so do their roles. Just because a factor occurs in two levels does not mean that it will occur in both places in the same manner or that its role will have the same effect on the nature of level—difference must be expected.

Here is an example using the general pattern of organization, cube. Eight small cubes can be combined to form a larger cube (Figure 7). The small cubes are components of the large cube, and there is then a hierarchic structure of two levels. The small cubes have coherent structure based on molecular bonds. They are robust and can take a hit without distortion.
Are Ecosystems Alive?

The cube constructed of cubes has noncoherent structure held in place by gravity in relation to the shapes of smaller cubes. The large cube is not robust because the noncoherent relations between its components leaves it vulnerable to a blow, which would knock it apart. The higher level is different because the additional level adds a layer of complexity, allowing for a different kind of relation between components. The roles of the factor cube at the two levels are different. The lower level cubes can play roles that require robustness, and roles appropriate for cubes of their size. The higher level cube cannot play roles that require robustness, but it can play roles for a cube that is larger than a lower level cube.

There are a great many kinds of development. Development is the single most significant factor of general systems in that it is the only one that is completely universal, with all other factors of the infinite universe occurring within it. The transition from one part of space to another part is a form of development. The change that is time is another form, as is the change that is motion (Vesterby, 2008). Biological evolution, ontogeny, and ecological succession are developments. Learning, dancing, and making artefacts are all developmental processes. Plate tectonics, orogeny, erosion, and the deposition of an alluvial fan are developments, as are ocean currents and weather. The ongoing burning of a star, the ongoing orbiting of its planets, and the turning of a galaxy are cases of development. And the hierarchical organizations of material reality from elementary particles to galactic clusters are forms of development. There are a great many more. Clearly, understanding development does what general systems is supposed to do—it transports you across all the disciplines, across all reality.

**Figure 7.** An extra hierarchic level provides a place for a different kind of relation between components.

To use development in that manner, as an intellectual tool of exploration and understanding, requires understanding the intrinsic nature of development as a general pattern of
organization. The difference between major developments and minor developments is one of the more general and more important aspects of this factor that must be understood.

Here is a simple situation to demonstrate this difference. A drinking glass is in a sink under a tap, and a slow but even flow of water is filling the glass (Figure 8). There is a progressive change in the level of water in the glass. There is no other change in the ongoing development of this situation, and this is a case of minor development. The rim of the glass is a structural threshold of the situation over which the water eventually spills. This is an abrupt change with differences in what is happening. The level of water in the glass is no longer changing, and the water is no longer contained by the glass. Soon the amount of water leaving the glass equals the amount entering the glass, and a steady state develops. Once more there is no other change in the ongoing development of this situation, and it is a case of minor development. There is again a progressive change, water entering and leaving the glass, but this steady state form of progressive change is entirely different from the progressive change of water slowly filling the glass. The development of the situation when the water reached the rim of the glass was a major development, and there were major differences in the nature of the situation thereafter.

![Figure 8. Threshold leads to change in the nature of what is happening.](image)

The situation of ongoing minor changes, then a major change, then ongoing minor changes of a different sort, is itself a general pattern of organization, like threshold, steady state, emergence, or self-organization, that occurs again and again throughout the universe. An example is the steady development of the structure of the series of atoms by the progressive addition of elementary particles, then the major development of atoms combining with atoms, and the consequent progressive and diverse development of molecules and molecular complexity. Another example was all the abiotic chemistry that was taking place on earth before the origin of genetic mechanisms, that major biological development, and then the progressive and very different chemistry of life that has lasted without interruption these past few billion years. One more example—this one being the nature of evolution that took place by way of the cell division of unicellular organisms prior to the developments of multicellular organisms, then that set of major developments (fungi, plants, animals), and the consequent extraordinary kinds of evolutionary developments that then followed.
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When unicellular organisms began dividing without separating and eventually evolved multicellularity, the consequence was the emergence of a new level of the general pattern of organization we call life. The new level of life started out like the prior level from which it developed—it existed in the form of coherent units. Many forms of this level have become even more like the prior level in that they have evolved to be compound systems contained by an outer barrier—a developed form of coherent unit.

Miller’s living systems theory proposes a development of seven levels of living systems: cell, organ, organism, group, organization, society, and supranational organization (Miller, 1978, p. 1). The first three levels are coherent systems, while the last four are noncoherent systems. The transition from organism to group is a major development. The first three levels are unequivocally living systems. The last four levels are unequivocally systems with living systems as components. Miller proposes that the noncoherent systems are living systems, and it is this idea that can lead to the question about the living system status of ecosystems.

Miller is saying that just as a new level of living system emerged with the evolution of coherent multicellular organisms, a new level of living system emerges with the noncoherent interactive association of a group of organisms. This idea, however, does not take into account the significance of the differences that occur after a major development. The primary difference has to do with coherence and noncoherence. In the known cases where a second level of life developed, it always occurred by way of vegetative growth—cell division directly into coherent bonding, and a coherent second level. There is cell division, and association of cells, a coherent association. The case Miller proposed does not occur by way of vegetative growth. There is organism reproduction, and association, a noncoherent association. Miller is claiming the origin of a new level of living system by way of a process which is opposite from that by which all other developments of a second level of living system have occurred before. It should be noted that no evidence has ever been found that indicates that over the past several billion years a new level of what is obviously a living system has ever evolved or come into existence by way of noncoherent association of units. The transition from an organism to a group of organisms is a major development, and major differences in the consequences must be expected, not ignored.

Miller gave nineteen critical subsystems that he believed constitute a living system, and he believed that these subsystems occur in each of his proposed seven levels of living systems. “Together they make up a living system, . . .” (Miller, 1978, p. 1). The idea that this set of subsystems always constitutes a living system does not take into account the significance of the differences that occur with factor development. Factors occur in different forms in different situations because of differences of how many other factors are playing roles there, how many factors are playing roles in the intrinsic makeup of the factor itself, what the factor is made of, and the hierarchic depth of organization involved. The result is that different forms can have different roles, which can have different effects on the nature of the situation in which the factor occurs. The transition from one stage of the development of a factor to another stage usually involves differences in form, role, and the effect of the factor in the developed stage, which must be expected, and not ignored.

The nineteen critical subsystems are factors which develop through Miller’s seven levels. He recognized factor development, for example the role of DNA in a cell and the role of a charter in an organization. But he did not account for the differences. There is a significant difference in the form of the reproducer subsystem at the lower three levels and at the upper four levels.

A unicellular organism reproduces by division into two cells. This process does not involve the creation of new life. There are now two cells, but the living processes of those cells are
just the living processes of the prior cell divided into two parts. This is how it has been since the beginning of life. The ongoing chemistry of life has always been passed on uninterrupted in this manner. The reproducer subsystem of a unicellular organism confers life by passing on life itself. Both the organ level and the organism level are created in exactly this manner, by cell division, by life being passed on, cell division by cell division, through the process of growth. With the first three levels, the reproducer subsystem passes on life, life itself, uninterrupted.

At Miller’s level of an organization the form of the reproducer subsystem is entirely different. Consider the difference in what molecules DNA is made of, and what molecules a paper and ink charter is made of. The processes by which each plays its roles are, again, different. The effects, then, can be quite different in that charters, in general, do not code for proteins. The reproduction subsystems are different in forms, specific roles, and specific effects. The one confers life by passing on life. The other confers life...........How? When an organization copies its charter, and sends off a team of its members with that copy to a new territory to establish a duplicate organization, there is a duplication of the charter and a division of the members of the prior group. Miller claimed that this is a living system reproducing and creating another living system. But where is the life? The actual life of the system still resides in the component organisms, the people.

The mere presence of a factor or a specific set of factors at two different levels does not render those levels the same. It does not make the systems at those levels the same kind of systems. The presence of forms of Miller’s nineteen subsystems at the level of an organization does not make an organization a living system—it does not make the organization alive. Actually, the methodological expectation should be that the levels will be different, that the nature of the systems will be different. The difference in the forms is so great that rather than expecting a charter to contribute to its level being a living system, the expectation should be that that form of the factor would more likely prevent the level from being a living system.

REFERENCES
ABSTRACT

When modernization of pathways for handicapped accessibility and an outdoor meeting patio is resisted by a campaign of public agitation under the guise of historical preservationism, architectural taste, traffic and fire safety, etc., is it any wonder that eyebrows are raised about the true motivating forces behind such agitation? Based upon the author’s use of a wide variety of social psychological and sociological theories to understand how to manage “BUREAU-cratitis” (ISSS 2002) and the convergent rise of a curious case of legalistic manipulation of county bureaucracy against the clear mission and goals of a private educational and scientific research organization, namely a botanic garden in a beautiful outdoor canyon, illustrations of tentative theoretically based causes and possible solutions to the largely social and cultural, as well as environmental intermix of problems will be given. Theories to be applied will include Conflict, Cognitive Dissonance (Festinger), Labeling (particularly as techniques of neutralization, “denial of responsibility,” “denial of injury” toward one’s opponents, and “appeal to a higher loyalty,” as developed by Sykes and Matza: 1957), Role Bargaining (W.J. Goode), functionalism (in terms of the functions of ignorance as stated by Moore and Tumin: 1949), Identity Bargaining (Erikson), modes of Synergy (Coulter: 1976), and perhaps most pointedly, Game Theory. The issue around what is called the “Meadow Terrace” project came to a head in the middle of 2007 in Santa Barbara, California, when a county Planning Department approved the project, but after it was at least one-third finished (at the expense of $72,000.00), some canyon neighbors with their resident lawyer mounted a campaign that caused a new Planning agent to rescind the permission to firm up the pathways and gently sloping patio/display area with level, natural stone, and to build three supporting outdoor terrace walls of 18 inches high for easier accessibility and a more level gathering place in the meadow, surrounded as it is by tall trees, and in the general vicinity of seven previously specifically designated historical landmarks located around or between the original botanical library and a dam across a canyon creek-bed. In the process of previous historically sensitive compliance, did the Botanic Garden (BG) give up its rights to modify any aspect of the tracts of land containing those seven landmarks (without a full-scale environmental impact report), including cutting down nearby dying or dead oak trees, or firming up the pathways across the meadow for easier access by wheelchairs or persons needing medical walkers? Did the BG relinquish its rights to use any of the remaining space within those partly historical tracts to continue to accomplish its educational and scientific mission (i.e., botanical research)? Ignorance by neighbors, and by the county bureaucrats about the actual nature of the planned terraces (and about other modifications of libraries and staff offices and teaching facilities in another area of the historically designated tracts), and the complainants’ lawyer stating
the neighbors’ virtual claim to jurisdiction over the entire historically pertinent area, including over the low level terrace leveling project, caused a furor characterized by public debate in meetings of the HLAC (the county’s preservationist overseers, who are not expertly trained in botany or education, if even archaeological or historical methodologies, namely, the Historic Landmarks Advisory Commission) and the county Board of Supervisors, few of whom showed a clear understanding of the botanical (scientific) mission of the Garden or of the legal limits of designation of the seven sites on the grounds, in contrast to the overblown aesthetic and historic preservation ideology. Keywords: Policy System Theory/ “BUREAU-aratitis”/ botanical science/preservationism.

I. ISSUE AND THEORY OVERVIEWS

Some key questions to solving the Meadow Terrace Legal Case include:

1. Where was the original intent of the donors of land to what became the Santa Barbara Botanic Garden (BG) stated to be “static preservation” or primarily historical landmark protection over and above educational and scientific endeavors? [Quote exact language.]

2. What is the exact nature of restrictions (on land usage) signed onto when the seven historical sites (as opposed to parcels within the tracts) were designated as Historical Landmarks concerning the surrounding ground?
   A. Where is the “historic design concept” defined (legally)? [See BG lawyer, Battles’ 8/22/07 letter to HLAC, pg. 3, for the last two questions.]

3. Exactly where is the priority of dynamic, evolving, educational and scientific (botanical) work stated in writing as the mission of the BG in relation to the “original intent” of the founders (including at each stage of land expansion since 1926)?
   A. What portion of the 32 total acres containing the seven named historical sites must not be altered on private ground around those sites (according to those inclined to define the situation in that manner)?
   B. Under what conditions can the County Planning Department’s extremely legalistic and arbitrary rescission of permission to construct the Meadow Terrace (in the middle of the project) be reimbursed for the $72,000.00 or more expended by the BG?
      1) Why was estoppel (of SCD & Planning’s permission to construct Terrace retaining walls) not invoked by the county (despite the fact that there was no Permit per se, but only the virtual equivalent, if common sense were to prevail in this case)?
   C. Why would it not be advisable for a Garden representative to search for an alternate Garden site for developing the Garden in a more expansive site, with more adequate space for housing its botanical research and educational missions?
   D. Request rescission of Resolution 2003-059, the agreement in 2003 to designate the seven designated historical sites within three assessors’ parcels inside the Garden area. What if anything could prevent this in the
series of gifts and the Garden’s founding documents and purchases of additional sites since its founding in 1926.

Refer to Chart #1, a “Non-structural Landscaping Plan: ‘Players’ and Concepts---Pandora’s Boxes. Overall this chart divides up the issues into two rectangles and two circles containing aspects of a) public Bureau-CATS, b) Rules, c) the initial protagonist, in this case a Non-Profit Organization (NPO), the Santa Barbara Botanic Garden (BG), and d) the Activist clique of agitator neighbors. Suggestive arrows indicate possible lines of influence between the parts applied to the case of conflict between the activist, preservationist neighbors who call their fund-raising group the “Friends of Mission Canyon” (“Friends”) against the Botanic Garden’s management, staff and extensive roster of supportive volunteers.

II. IGNORANCE AND COLLECTIVE ‘CLIQUEING’

Now come four lists in the area of collective behavior which can be employed to illustrate possible motivations or pressures seemingly illustrated by the “enemies” of the Garden plans (most applications being relegated to the appendix in the interests of space saving):
1) Recognizing a cult (with 5 point or sub-points), 2) Seven Steps and devices for influencing the mind of a cult or clique, 3) Six elements of crowd behavior, and 4) Six aids in the circulation of rumors. [To save space, see details of the first two lists, recognizing a cult and influencing the mind of a clique, in the appendix, available on request.]

1) ELEMENTS OF CROWD BEHAVIOR: Observers of the “Friends” will see six points:
   1. The situation is ambiguous and unstructured.
   2. A feeling of urgency is nourished (enhanced by the Real Estate balloon or the current, 2008, downturn via the housing crisis, war and oil depletion, global warming situation, the widespread and nearby Zaca Fire of 2007, etc.).
   3. Norms emerge: The crowd generates a mood, a set of images, and a consensus as to what actions are good, right, or necessary.
   4. Increasing pressure on those who do not share the general mood (through flyers, phone calls, web site messages, public meetings, etc.).
   5. There is a sharply heightened individual sensitivity to the moment, of emotional suggestibility, and responsiveness to the collective mood, for example at the time of public hearings and testimony.
   6. Attitudes and actions that would normally be inhibited are permitted expression. (The main points came from Turner and Killian, 1957, Collective Behavior, as restated in the Dabaghian teacher’s manual for Soc. 100.)

2) AIDS in the CIRCULATION OF RUMORS:
Aspects in the “ruining” of the aesthetic preferences or historic, landscape architectural views of the not so neighborly clique followers.
1. A high degree of social interaction and (the perception of) the necessity for action.
2. Similar wishes and fears of the members.
3. People have an unsatisfied need for information and must depend on one another (rather than on the public announcements of Garden officials and staff members, or county officials).

4. Monotony. (Many retired persons or housewives, seekers of isolation and silence, live in the Canyon, having moved there to get away from the hustle and bustle, see their self-defined garden get-away threatened and change from their original, first remembrances of it).

5. Tension. (The massive 2007 Zaca Fire, traffic and parking fears, potential noise, and threats to their early view preservation, potential downgrading of equity or Real Estate value in their homes which has ballooned in the last couple of decades to unreasonable,
unrealistic, and even to un-recoverable proportions, all likely have created tension in
the minds of a minority of residents).

6. A high degree of rapport. [In this case, the rapport has apparently grown to a fever
pitch between the “Friends,” their lawyer, the president and officers of the MCA (Mission
Canyon Association), and sympathetic county officials, as well as historical
preservationists of the Santa Barbara area, influenced no doubt by the ever-increasing
growth and crowding in the area in and around the already expensive area of Santa
Barbara, with its high in not unaffordable-to-newcomers cost of living].

Next there follows consideration of Chart #2, in two-columns (adapted from Moore and
Tumin, 1949), a list first in the left column of most of their “social functions of
ignorance.” Then in the second column are corresponding statements applying each of
the functions, mostly to the “Friends,” who might well be called “enemies” of the
Garden’s long-studied and professionally designed upgrading and detailed expansion
plans known as their “Vital Mission Plan.”

FUNCTIONS OF IGNORANCE by cultic “Enemies” or Bureau-CATS: CHART #2

<table>
<thead>
<tr>
<th>Pertinent generic FUNCTIONS:</th>
<th>APPLICATIONS to Meadow Terrace case:</th>
</tr>
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<tbody>
<tr>
<td>III. Ignorance of what is actually</td>
<td>a. When the “Friends” (i.e., the “enemies” of</td>
</tr>
<tr>
<td>going on <em>reinforces traditional values</em>: In particular,</td>
<td>the plans of the Botanic Garden) do not understand the</td>
</tr>
<tr>
<td>A. Isolation of a person from</td>
<td>intended plans, or choose to twist BG’s intentions,</td>
</tr>
<tr>
<td>revealing facts about one's place in society or the workplace reinforces</td>
<td>their fears and the basis of their local family</td>
</tr>
<tr>
<td>&quot;traditionalism&quot; in points of view.</td>
<td>ancestors’ “traditional value” feud is “reinforced.”</td>
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<tr>
<td>B. Ignorance of normative violations by others does not give</td>
<td>b. BG’s ignorance of (legalistic and devious if not</td>
</tr>
<tr>
<td>any incentive to the person to try to gain an advantage by perpetrating</td>
<td>illegal) “enemy” intentions gives BG managers no</td>
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<td>the same violations.</td>
<td>incentive to defeat or quickly terminate the</td>
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<td>C. Lack of knowledge of actual,</td>
<td>c. BG’s lack of knowledge of the factually</td>
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<tr>
<td>perhaps dysfunctional or destructive</td>
<td>ignorant and irrational intent of “Friends,” and</td>
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<td>activities allows one to continue to believe that the publicly perceived</td>
<td>their hangers-on allows BG supporters to believe</td>
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<tr>
<td>&quot;group mandates&quot; are acceptable.</td>
<td>that the false rumors of BG intentions and plans</td>
</tr>
<tr>
<td>IV. Preserves privileged position:</td>
<td>spread by the “Friends” have legs to stand on.</td>
</tr>
<tr>
<td>A. The specialist in an area of knowledge may know things that if</td>
<td>d. If the public or the staff and BG supporters</td>
</tr>
<tr>
<td>the consumer would understand would lead the potential consumer not to buy the</td>
<td>knew the legal fine points of the Meadow Terrace</td>
</tr>
<tr>
<td>product.</td>
<td>case (“taking,” external micro-management, vs. the</td>
</tr>
<tr>
<td>B. The specialist may have knowledge that would give competitors an advantage, so s/he</td>
<td>scientific, but subordinated and very limited</td>
</tr>
<tr>
<td>e. Specialists like lawyers (for either side) will</td>
<td>historical) purpose of the BG, they would not buy</td>
</tr>
<tr>
<td>most often limit dissemination of fine points of the law that might be crucial to understanding or</td>
<td>into the rumor-mongering and log-rolling of the</td>
</tr>
<tr>
<td></td>
<td>“Friends” about loss of landscape architectural</td>
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<td></td>
<td>views &amp; RE$.</td>
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keeps the pertinent information secret. | resolving the case. What limits were intended on HLAC jurisdiction in the 2003 Resolution on the 7 sites?

<table>
<thead>
<tr>
<th>C. If roles in the division of labor in an organization or group are widely <strong>differentiated</strong>, each role incumbent can more easily <strong>maintain power</strong> in his/her separate domain.</th>
<th>f. If roles in county bureaucratic departments are severely delimited or differentiated (e.g., Planning vs. safety, vs. Fire, vs. Water, vs. environment, vs. Historical Landmarks, etc.), each bureaucrat or staff member can appear to be correct within their separate domains, but all are then more likely to miss the whole picture, such as the primary intent of a Botanic Garden.</th>
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<tr>
<td>D. Too much knowledge of the privileges or differential rewards of others doing the same or related jobs may lead to jealousy over the unequal rewards, hence ignorance of such information <strong>avoids jealousy</strong>.</td>
<td>g. Members of one county, state or federal department with some jurisdiction over a given overall project, e.g., the Vital Mission Plan, are generally ignorant of the domain of most other departments, and hence no one “asks too many questions” about the jurisdiction of others lest, on the surface, “self-destructive” disputes or jealousies arise.</td>
</tr>
<tr>
<td>V. Ignorance <strong>preserves stereotypes</strong>: A. The perception that a bureaucratic organization is running smoothly is easier to maintain if inside knowledge (whether &quot;dirt&quot; or factual but uncomplimentary information) is not too widespread.</td>
<td>h. The less any one department or pressure group knows about the whole picture or most pertinent facts, the more they are likely to keep fanning the flames and keep the feud going. The failure of the BoS to understand the facts or to clearly state reasons for their dismissal of HLAC testimony or votes has lead Supervisors to vote on instinct or misguided trust in their non-professional appointees, not only without discussion of facts, but without a serious rationale for their actions.</td>
</tr>
<tr>
<td>B. Ignorance of the truth about a person (or say a &quot;candidate&quot; for an occupation or promotion, or salary increase) <strong>preserves stereotypes</strong> about the person. The usually negative characterization of the person may by based on ethnic or class stereotypes, or snap judgments about personality, philosophy of life, or philosophy of education. This is especially insidious if judgment is made before getting to know the person or discussing his/her motivation face-to-face, or in the case of a personnel decision or recommendation, before reading and thoughtfully discussing the person's written profile.</td>
<td>i. The Board of Supervisors apparently appointed HLAC commissioners who were for the most part not trained or credentialed in history, public law, horticulture, botany as a science, landscape architecture, education or management of non-profit, public service organizations.</td>
</tr>
</tbody>
</table>
BUREAU-PATHOLOGIES

Adapted from: "Some Social Functions of Ignorance," by Wilbert Moore and Melvin Tumin, American Sociological Review, Dec. 1949. [Only the most pertinent partial set of functions are listed here from 4/09/02 file. The applications column is original and applies to the Meadow Terrace case by the author, Slawski. Numbers refer to original list with the first two, I and II, omitted as not applicable in this case.]

Chart #3 attempts to show the main theories on CAUSES promoting NIMBY CLIQUE MANIPULATION, starting from the upper left corner with collective or structural sub-theories, and from the upper right corner with personal influences (adapted from the author’s previous theories of the causes of terrorist actions, obviously on a different scale of violence). One key insight that can be gleaned from this flow chart is as follows. The whole problem of the Meadow Terrace caper must be considered from the micro as well as macro points of view, and within those two are many permutations, each of which can be explained in an integrative manner, one or two or three at a time in the tradition of General System Theory itself.

III. SOCIAL PSYCHOLOGICAL HYPOTHESES AND THEORIES

ROLE BARGAINING: Chart #4 outlines central critical facts and issues under three main headings (within the three circles), Cultural Role, Personal Role, and Situational Role, showing strains within each circle and between the three larger elements. Some points of interest gleaned here include the following. The elements of cultural outnumber either the situational or personal, though the emergence of crucial organizers were essential to developing the clique of “enemy” defining persons with time on their hands to make trouble for the BG. Personal fears would be legitimate if well founded and based upon genuinely verifiable facts of the BG’s “situational” plans, rather than on a few neighbors’ personal aesthetic tastes, and denying their own responsibility for road improvement, or their addition to the density of resident population, etc. In any case, the listing of the possible strains within and between the three types of role provides a comparatively easy overview of the problematic aspects of the Meadow Terrace case.
CONFLICT THEORY: Main hypothesis, #1: If there had been an initial and ongoing positive thrust in the relationship (between the Botanic Garden management and the neighborhood’s, i.e., Mission Canyon’s clique organizers), then the public legal conflict (or hearings over appropriate interpretation of the mission of the Garden per se and its responsibilities to the seven designated historical sites, rather than to the jurisdiction over the entire surrounding tract parcels) could have had a positive or “eufunctional” outcome.
More specifically, there should have been constructive requisites in terms of
1) **mutual empathic knowledge**, which in turn will take complementary initiatives to
   study the detailed documentation around the Garden’s Vital Master Plan, the
   lawyers’ competing arguments, the Uniform Building Code, county ordinances and
   the essentials of the HLAC role in regards to the implied and explicit written
   commitment the Garden officers made at the time of their agreeing to allow formal
   protection of the seven historic sites within the land legally owned by the Garden and
   its Board and officers, and

2) **integrative bargaining**, through representation of assertive neighbors on the
   Garden’s appointed committees to interpret the meanings of the Garden’s mission
   and obligations (static historical preservation vs. constructive growth along central
   educational and scientific lines) and in turn to implement the Garden’s (and its
   neighbors’) best long-term interests, both of which could in the long term lead to

**EUFUNCTIONS** such as

a) concentration in (future) public hearings (and private consultations with pertinent
   county officials) in terms of dealing directly with the main facts, evidence and
   RATIONALE (which were almost entirely absent in previous hearings by HLA
   Commissioners and the County Board of Supervisors), and

b) clarifying the BG’s rights, as well as sharpening the logic and consistency of the
   ministerial role of public officials (the Planning Department, Planning Commissioners,
   HLAC and Board of Supervisors).

Conflict Hyp. #2: **“Social distance is an inverse function of efficient communication.”**
Because of historical, cultural, family history, as well as regional dangers and real estate
balloons, and the neighbors lack of volunteer initiatives with the Garden management
consultation process, efficient communication of many neighbors with the Botanic
Garden recently failed, which in turn resulted in social distance between those neighbors
(an assertive minority clique calling themselves “Friends of Mission Canyon”) and the
management of the Botanic Garden.

Conflict Hyp. #3: “After “naturally selected” less-than-concerted action patterns are
repeated, they become institutionalized patterns of dis-concerted (even hostile or
oppositional) action.” Due to long-term family loyalties among a subset of neighbors, as
well as a mix of difficult, self righteous personalities who prefer historic preservation of
undeveloped land over educational and scientific development in the Garden, including
preservation of their own family’s memories of the good old days experienced there, a
movement has developed (known as “Friends of Mission Canyon”) designed with the aid
of a well trained but apparently legalistic lawyer trying to establish his local reputation as
a successful fighter of causes, a movement orchestrated to assert (obscure) legal rights
and changes to the legal mandate and mission of the Garden in the present day’s cultural,
fire safety, and economic issues.

**LABELING THEORY:** There follows a list of “NEUTRALIZATION TECHNIQUES:
NIMBY Words and Their TRANSFORMATION” involving five techniques (applied
briefly to the apparent or likely attitudes of the “enemies” to the Garden’s administrative leaders and their followers).

1. "DENIAL OF RESPONSIBILITY": Nurturing the 'sub-human,' recalcitrant destroyers of “our cherished pathways” mountain views from the Garden entrance, and fire safety. Education and scientific research are NOT OUR PROBLEM.

2. "DENIAL OF INJURY": Survival of educational & scientific missions is irrelevant to us. They are not our "good neighbors." They’re just not our kind. Harming "demons" or deep-pockets is a non-event.

3. "DENIAL OF THE VICTIM": "Them's our enemy. They're nothing but deep-pocket trash. Affection for "them" BG administrators could never be our concern. They're in league with our undefined fears and oppressors.

4. "CONDEMNING THE CONDEMERS": The paperrights of "them" is not our concern. What have "they" ever done to obey our aesthetic tastes, wishes or demands or our RE$ welfare?

5. "APPEAL TO A HIGHER LOYALTY": A moral code: The RE$ & lawyer $s are our higher laws, as is loyalty to our ancient Canyon family culture. To contribute to either is noble.


EXCHANGE THEORY Case #1, Chart # 5: “MCA → FMC” (Mission Canyon Association spins off its political activist wing known as the “Friends of Mission Canyon”), the whole referring to an Exchange Theory application first at t-1 (Time-One, the current Spring 2007 impasse) through the crucial ‘E’ or Intervening Event (the CAMPAIGN vs. Any Significant BG Development (Structures/Symbolic-Construction/Signs) to t-2 (the later Time Two, a Possible Future Solution). “R-C = P” stands for Reward minus Cost, resulting in the overall Profit for the protagonist, in this case the activist “enemies.” Some insights from this table might be that an economic analogy seems to be among the most revealing forms of analysis about the motivation and possible results of the conflict. At t-1 (“time One”) local insider-organizers have exerted a lot of time and energy in opposing Garden projects (showing reward for them of +3 on a –5, +5 scale), but also experience high costs (a +4, in terms of their organizing energy and lawyer’s fees), resulting for them in a risk of losing long-term overall benefits from the Garden’s professional development in terms at least of a likely rise in their overall Real Estate values in the Canyon. Future solutions (t-2) with a more cooperative attitude by the neighbors’ clique could provide neighbors and the Garden management and visitors with a more educational and scientific prize along with the satisfaction they would receive through constructive public service.
EXCHANGE THEORY Case #2: Chart #6: BUREAU-CATS [and PLANNING Department Bosses’] rewards less costs and the resulting profits are illustrated at three points in time, suggesting (at t-1) that the initial approval of the MT project was resulting in a routine positive outcome for them (as well as for the Garden’s future). At t-2, when the controversy was induced by neighbors, the Planners (plus HLAC commission and Board of Supervisors), an objective view would see the loss of face and likely long-term embarrassment of county officials at all levels (an outcome or profit of −1). At t-3, if the bureaucratic problems of the county could be improved in the process of recognizing the legitimate mission and Rewards of the BG’s long-term and MT project plans, again on private land, and the lessened Costs of recapturing the county’s integrity of decision making, the bureau-CATS could indeed gain a very high reward in the eyes of the public and objective observers of their operations. However, given the historical retrenchment or inertia of public agencies to changing their procedures voluntarily, the likelihood of this high positive outcome appears slim in the eyes of the present writer.
Chart #7: “A GAME THEORY Matrix for Non-Profit Public Service Organization,” applies a mathematically-oriented (in this case) social theory to the opposition between A (at the top), the options of the FMC (the Friends of Mission Canyon, otherwise known here as the “enemies”), and B (at the left side, representing the BG, or Botanic Garden’s strategic options, with the four squares in the matrix representing the estimated likely joint outcomes of simultaneous choices of the two sides.
In this case, A has a choice of X or Z; B can choose P or Q (as noted on the edges of the matrix). The first number in each box is the outcome of A for that set of choices, the second number is the outcome for participant B. One can judge most favorable outcomes for A by examining the estimated overall outcome for part A, and similarly for B. Obviously the upper left box is most favorable for both parties, since each receives a +5. The worst outcome for both is the lower right box, where the FMC receives a −3, and the BG receives a −5 (where each party loses, except of course the lawyers who take their fees regardless of whether they win or not, assuming they are not working on a pro bono or a contingency basis). It appears that the latter is the current situation (as of May 2008), but if the Garden toughens up its stance and wins with the aid of the Planning Department, the EPA, and other oversight bureaucratic agencies, etc., they could gain in the situation by moving to choice P (instead of Q), and as a result gain a minimum of +3
(upper right quadrant, wherein the still-hostile Friends would lose by an estimate of −4). However, if the BG continues to compromise with the ignorant positions of the county Planning, HLAC (Historic Landmarks Advisory Commission), and their supporters, the BG would only gain a +2 (with perhaps only a partial salvation of their Vital Mission Plan and staff facilities). This theory perhaps does the best at an overview of the strategic positions of either party, and may give some hints at the futility of giving in to the desire of preservationist enemies.

COGNITIVE DISSONANCE, Conclusions only --- 3 WAYS OF REDUCING Dissonance:

1) “A change in behavior opposed to a belief leads one to change his own behavior.” Specifically, if there occurs a realization by “Friends of Mission Canyon” of the irrationality and unreasonableness of their wishes and assertive requests, or their overrule by County HLAC, Planning department or Board of Supervisors, in that case the “Friends of MC” might give up their “coup” attempts, if not even take an active, constructive role in raising funds and influencing the betterment of the educational and scientific and accompanying essential development of the Garden according to its detailed and fully legally approved plans for improvement.

2) “A change in the environment or seeking support might help reduce dissonance.” Key members of the “Friends of MC,” including their locally residing lawyer, Marc Chytilo, could move to another location outside of Mission Canyon. Or the Garden itself could move its primary operations to another area or small city [e.g., Santa Paula, within Ventura County] that would be more friendly to the Garden’s plans for rational and aesthetic and botanical development. A realistic offer from such a potential host city or more bureaucratically friendly county officials might be a bargaining chip to help the Garden gain clout with Santa Barbara County’s currently constituted citizenry and entrenched local Bureau-CATS.

3) “Add new cognitive elements.” A totally new strategy might be invented or happened upon from inside the Garden staff or volunteers or from outside that would resolve the entire problem. It could be a major donor to press the legal rationality of the Garden’s case [perhaps someone on the order of Oprah Winfrey, the Hoffman family, or some combination of wealthy and scientifically influential persons on the order of a Nobel prize winner or receipt of some prestigious architectural prize]. A counter-suit against the “Friends of MC” might be developed on grounds of their possible conflict of interest or their defamation of character of the CEO, of influence-peddling with the HLAC or possibly a member of the Board of Supervisors or the County Planning Commission.

Other suggestions for the precipitation of an overriding earth-shaking event are welcome from the readers of these words, an event that would relieve the burden of a pathological case of regional NIMBY-ism, entrenched county bureau-CATS, anti-neighborly greed, or power-seeking by semi-old-time and self-absorbed nearby residents. [See supplementary appendix for details of the main analytical points of Cognitive Dissonance.]
GROUP DYNAMICS: There are primary groups in evidence in this case, such as the Garden’s initial founders and their descendants, and secondly, in sub-groups among many of the current Garden volunteers. The Mission Canyon Association likely contains a primary group within its core members. Secondary groups would include the occasional members of the “Friends of Mission Canyon,” the Historical Landmark Advisory Commissioners (HLAC), the Board of Supervisors, the Planning Commission and Planning Department employees.

Critical reference groups of special interest in this case are the Planning Commission, Board of Supervisors, HLAC, the Mission Canyon Association’s core leadership members, Garden staff, management and volunteer subgroups, the lawyer “dyad” (and assistants) for the Garden, plus the frequent public visitors to the Garden.

Normative reference groups include each of the county boards, commissions and agencies, as well as the “Mission Canyon Association,” each of which is also a membership group per se. Comparison reference groups would include leaders of other botanic gardens or historical preservation associations and groups around the world.

Key Hypothesis: GROUP COHESIVENESS (among “Friends of Mission Canyon” or in turn among Garden managers, staff, volunteers and members as illustrated by the opposition expressed by each side at the public hearings of the HLAC and again at the Board of Supervisors), through a communication process (the hearings themselves and the prior organizational and formal or informal meetings and conversations of each of the opposing parties to the Meadow Terrace case), INFLUENCES A MEMBER TO CONFORMITY (as evidenced by the “uni-ordinal” or almost black or white partisanship expressed in the public testimony of the 60 or so persons at each of the public meetings on the case in question).

However, neither the majority of Commissioners or Supervisors conformed to one single position. Rather they apparently had their respective minds made up before the public hearings, ignored the testimony of the numerous witnesses, had no in depth discussion after the testimony, made legalistic motions to suppress a valid decision at all, or decided to vote while still admitting that the full facts of the case were not understood by them (or appeared to them to be only more of the same indeterminate factual detail presented in prior documents, garden tours, or descriptive meetings by Garden staff).

The leadership style of communication was 1) authoritarian coming from most of the public bodies, the Planning department officers, HLAC and Board of Supervisors. The decisions from the Garden were democratic, with many elements of laissez-faire entering into certain aspects of the pre-planning process. The communication process within the Mission Canyon Association and the “Friends of Mission Canyon” appear to have come out of a democratic process, hence leading to the consensus actually reached within these democratically initiated “reference groups.” The Garden and the “Friends of MC” respectively are likely to be long lived because based upon consensual influences. One would presume that the communication processes within the county departments, commissions and boards would be more malleable and short-lived (coming as they did on
a largely authoritarian or opinionated basis), especially since a majority of such public officials are likely to realize that they voted without benefit of serious in-depth and legally fully-informed information and without an expressed rationale based upon evidence hashed out in the discussion before their respective peremptory votes on the Meadow Terrace issue in December of 2007 (for the HLAC whose entire hearing was dismissed without expressed cause by the Supervisors), and then again in January (?) of 2008 (for the Supervisors’ hearing). These kinds of shenanigans give the writer little hope that a rational decision will eventually emerge from the process, and above all bode well mainly for the filling of the seemingly greedy pockets of the lawyer for the so-called “Friends of Mission Canyon.”

**SYMBOLIC INTERACTIONIST** hypotheses suggest: There might be a common overlap of perspectives across the four sets of parties, namely 1) the majority of Mission Canyon residents, 2) the “Friends of Mission Canyon” pressure group, 3) the Management of the Botanic Garden, and finally 4) the Santa Barbara County agencies, Planning, Historic Landmark Advisory Commission, and ultimately the Board of Supervisors. More specifically, the commonalities in perspective are referred to (as indicated by the American Pragmatist philosophy of George Herbert Mead) as the “generalized other”. When this common perspective is finally recognized by all parties, then there could possibly result some form of overall CONSENSUS in the actions regarding the BG’s Vital Mission Plan. Subordinate hypotheses include H1: When there is a lack of a common definition of the situation, consensus will fail. H2: This will in turn lead to fragmentation and in turn to the continued invocation of the self aggrandizing social control mechanisms (or maintenance of local power if not prestige) by the organizers of the “Friends.” H3: Failure of the “Me” (or internal censuring conscience among the “Friends”) to guide their “I” (subjective impulses to act) will continue to lead to each party’s misconstrual of the others through their separate but mostly false role-taking (or empathic) processes. Even if one side continues to act in what might be called a sociopathic manner, at least the erroneous party will continue to misconstrue their opponents and the true facts of the case (the legal rights of the private Garden with its non-profit educational and scientific work).

**THE SYNERGY MODE LADDER:** The major players on the side of the Garden appear to be at least at the MULTIORDINAL mode of thought, being aware of two or more perspectives at once (e.g., those of the Planning department and their own staff needs, if not also the views of the majority of their residential neighbors), as well as how their actions may affect others (the visiting scientists and even the oppositional or hostile neighbors). They appear to be empathetic, multi-purposed, serendipitous, open to modifying their own ideas or actions, although without sacrificing the principles of their mission, that of education and scientific (botanical) research.

The Garden leaders appear to be for the most part even characterized by a SYNERGIC mentality, or at least a multiordinal mode, because they are sharply focused on things that promote two or more viewpoint, goals, perspectives, while impeding none, potentially leading to a new holistic level of integration. They are sane, fully rational, ethical, operating without distorting, distinguishing maps from the territory, and quickly making
BUREAU-PATHOLOGIES

corrections in the maps (or long-term plans, the Vital Mission Plan?). In contrast, it appears that the majority of those testifying against the completion of the Garden’s Meadow Terrace project are UNIORDINAL thinkers at best, because they do not distinguish shades of truth with facts, are of limited rationality, and do not seriously consider the viewpoint of the Garden (except as the Garden’s plans are seen to be erroneous), though they do not appear to have serious mental disorders. They seem to think at the lowest two modes, identic and reactive. More specifically, (at mode level #2) their thinking is typically REACTIVE, driven by emotion (fear, anger, greed, guilt, etc.) evaluating without accurate evidence, rigidly holding their extremes or polar opposites, right or wrong, good or bad (our fantasy wishes and remembrances over the Garden’s rational and legal construction plans).

The “Friends of MC” also even appear at times to operate at the lowest level of thinking, the IDENTIC mode, characterized by a mind that is suggestible, basing their judgments on tacit identifications or the steps of “labeling” theory, operating as if hypnotized, and subject to propaganda. They believe what their lawyer and old-timer canyon residents suggested to them (however propagandistic) about their fears of property value declines, plus fire, traffic and safety issues. It is hard to believe that seemingly rational and normally well educated persons will grab onto such mistaken, extreme positions of self interest despite their ill-founded fears, perhaps about saving their neighborhood from currently declining property values and memories of ravaging fire in the nearby hills in 2007.

“Simplified Core GENERAL SYSTEM HYPOTHESES,” reduced to two hypotheses (from a list of 29, Slawski 1995), are stated here parsimoniously, then applied to case managers or other leaders in the Meadow Terrace case.
A. CONFLICT INTEGRATION: The more conflict promotes a) increase in creativity, b) release of hostilities, c) normative regulation, d) awareness of realistic issues, and e) associative coalitions, then the greater will be the internal social integration, and the greater the capacity to adapt to a system’s environment. As applied to case: The more the Meadow Terrace affair inhibits a) creativity or structural development of the BG, b) release of hostilities, c) normative or legal regulation of development, d) awareness of realistic issues, and e) associative coalitions like the FMC, then the less will social integration occur between the FMC and BG management, and the less will be their common capacity to adapt to the Canyon system’s shared environment (including fire, traffic, parking, and road safety, etc.).
B. REDEFINITION OCCASION: When the parties redefine the situation, then new patterns will occur. When the two parties redefine the situation (of the Meadow Terrace and long-range Vital Mission Plan in relation to the environmental impact report CEQA), then new and more cooperative patterns are more likely to emerge [if the FMC takes on a more rational attitude to the BG].

IV. POLICY THEORY APPLIED TO BUREAU-CRATITIS

Chart #8: The same original four-node basic diagram is the basis for a list of “FAILURES BY ALL” in the contest.
No one seems to be without error if not at least the failure to anticipate the overblown nature of the contest. The BG managers understandably assumed that their legal rights would prevail, and permission to go ahead with the MT project would stand. But they did not anticipate the political connections and strength of the movement of so-called "Friends." Nor do they have a web site dedicated to countering the slings and arrows launched by the "Friends." The Activist Agitators (the "Friends") appear from their public testimony to be hung up on imagined history and misplaced fears, coming across as petty Bourgeois NIMBY's fed by the one-sided but clever antagonistic motions and
arguments of their lawyer, all of whom choose to ignore the primarily educational and scientific mission and goals of the BG. The mostly county Bureau-CATS showed publicly that they did not take the time carefully, if at all, to read the legal arguments presented by the Garden and its lawyers. Other county officials and overseers, as usual it seems, attempt to cover their mistakes with ministerial blinders over the spirit and intention of codes and applicable laws. This makes it impossible to expect anything but arbitrary and capricious behavior on the part of individual county role incumbents, and even appointed commissioners and department heads, not to mention elected county Supervisors. The RULES are interpreted by seemingly politically-instructed or partly tuned-in counselors. The result is that discretion is used to rescind the project despite claims that they have only a ministerial but not an enforcement role in the whole process. Glib lawyers’ verbal fudging, as is common in the profession, puts the letter of the law (and code) over the spirit. There appears little hope that creative, let alone synergic thought modes, will ever stimulate a more humane and consistent interpretation and enforcement of the codes and laws applying to legitimate builders, even for public service projects in private hands.

Chart #9: The same four-figure basic diagram as the previous one, also provides an outline structure, for an overview of “PRACTICAL RECOMMENDATIONS: POLICY THEORY” with illustrations mostly inside the four figures. Some ideas for future action are suggested here, as follows. 1) The agitators (“Friends”/”enemies”) need to get educated on the legal rights of a private non-profit organization, accept the law, and learn some basics of the science of botany and the practicalities of landscape. 2) The Garden could among other things hire a legal assistant with hardball public relations skills on a nearly full-time basis, publishing its positions and the facts of its mission and goals on a dedicated web site. 3) The county and other bureau-CATS should take independently-run seminars on due process, valid and fair interpretation of codes and the spirit of the laws as opposed to the letter of the law lumped into a procedural, and presumed purely ministerial (but self-aggrandizing or error-hiding) obligations. 4) The rules (and laws) themselves need to be interpreted in a set of understandable flow charts about county and higher government procedures that put them into a common sense format, not for lawyers only, that would transcend boiler-plate legalisms.

The supplementary external Appendix will contain a Chart with a generic list of “When and Why Disclosure...Can Improve COMPLIANCE and the Rules Themselves.” This list could be very useful as a guideline for the public bureaucrats as well as the non-profit organization. Also in the supplementary appendix will be a generic summary list (from C. Argyris, Overcoming Organizational Defenses, 1990) of how defensive reasoning occurs, its routines, and thus why organizations, such as public agencies, if not also non-profits and their enemies may not adapt or plan ahead adequately, or be open to creative solutions or failures to plan for the worst case scenario, represented by the present seemingly senseless conflict.
COPING WITH MANIPULATIVE OPPONENTS [The So-Called “Friends” clique and their virtual allies among county BUREAU-CATS]

Among the twelve or more points the author stated in (4/14) 2003, two that have not been sufficiently successful to date [as of April 2008] seem especially pertinent at the present reading.
#9. Seek **participation** in the enforcement process of a maximum number and the highest quality of allies who subscribe to the desirable universal principles at issue. In the present Meadow Terrace case, this rule might be aided by a well designed and accessible web site to keep allies (and perhaps reachable or convertible “enemies”) fully informed about the exact nature of the issues as well as the key points of an ongoing public relations campaign. Even web-based regional newspapers and editorials could thereby be converted to the cause of justice as seen by the Garden supporters. Legal advisers (already operating in the case at issue) ought to be working effectively or consulting behind the scenes, and publicizing the most trenchant point possible, both openly and publicly when strategy and tactics deem it desirable.

#10. **Repeat and restate** one’s principles and processes publicly.

[Recommendation #9 (above) also supports the same principle.]

In the end, despite virtual collaboration with the “manipulative enemy,” one would hope that the “wayward Bureau-CATS” (county officials and staff) would see their way through the “BUREAU-cratitis” that they (in league with their somewhat unwittingly self-serving staffers primed by the agitators’ cultic manipulation) have somewhat unwittingly created while simultaneously working against their own best interests, the public welfare and the priceless advantage of having such a jewel in their jurisdiction (as the Santa Barbara Botanic Garden in the county’s Mission Canyon area). The purpose and mission of the Garden, educational and scientific (botanical) advancement, have in this bizarre and devious process been, wittingly or not, trodden upon with a vengeance by both the “enemies” (i.e., those who euphemistically call themselves the “Friends” of Mission Canyon), in league with their clever (perhaps also greedy and career-seeking) lawyer (also a resident of the canyon) and their sometimes misguided (cushy government job holders, acting toward their own promotion or to maintain their career and retirement benefits, who have thus become) willing collaborators, the county officials, who might be deemed bureaucratic allies of opponents, to whom several county officials appear to be beholden. In this way, the next and last critical point is illustrated, as follows.

#12. **Act decisively** to contain the opponent. **Do so as openly as practicable, and with just sufficient force, while minimizing innocent casualties and collateral damage.** This might even include presentation of long-term bargaining chips such as plans to shut down or sell the Garden site as a whole and moving the educational and scientific enterprise to another very desirable area where public jurisdiction and favorability will demonstrate a welcome mat that seems to have been destroyed by local bureau-CATS incompetence in dealing with or failing to deal with the main documentable and legitimately rationalizable common sense facts of the case.

**PRACTICAL QUESTIONS to Plan Opponents and BG Management:**

I. When was the **first large group event** (over 15-persons) held at the current Meadow Terrace site?

A. In what year?

B. How frequently was the site used for large group events since then?
II. In what **direct ways** have you tried to **influence** the BG’s construction, landscaping, or aesthetic **plans**? For what reasons or what **purpose** did you seek such **influence**? Aesthetics? Distant view alteration? Amount of construction? Architecture? Landscaping? Parking? Fire safety? Historical preservation? Botanical research? Horticultural projects? Educational programs? Wheel-chair or medical walker access? Bucolic aesthetics? Potential influence on neighborhood Real Estate values?

III. How much of the full expansion or development plans (the Vital Mission Plan, EIR, etc., plus accompanying appendices with detailed future plans) are readily available to a **non-member citizen inquirer**?

IV. What is the name of the architectural or landscaping **firm** that was **consulted** and began building the terrace project in mid-2007?

V. Ultimately **who decides** upon the final choice of aesthetic or landscaping qualities of a project (such as the Meadow Terrace)? 1) The consulting firm? 2) The VP’s with the CEO? 3) The new Development VP? 4) Any other committee inside the BG?

[If the latter is involved, which specific persons or committees have influence?]

A. Which present management **person had the most influence** on the choice of design for the Meadow Terrace (as presently constituted)?

   1. What was that person’s **rationale** for the main features of the area most recently used as an eating or meeting/gathering place?

B. *On what **bases** are project **decisions** ultimately made? Financial, functional, aesthetic, employee or volunteers’ opinions, neighbors’ complaints, other? [Starred items are judged to be among the most crucial questions for reaching a solution.]

C. *What are the **job qualifications** (training, degrees, skills or experience pertaining to scientific, educational, landscape architectural, archaeological or anthropological degrees, or horticultural skills, aesthetic judgment, etc.) that are required before being hired for an investigatory, advisement, or enforcement position for employers like the EPA, CEQA, Fish and Wildlife, OSHA, Police, Fire, Grading, Road construction width, turnouts, turnarounds and surface qualities, HLAC, County Planning and Development department, or a landscape architectural firm)?

   1. Within such agencies or firms, who makes the final, **ultimate recommendations**, including the **decision** about what features and aesthetic qualities should be incorporated into the project development?

VI. *What **avenues are open to neighbors** (let alone to current BG members) for influencing BG building and landscaping plans **from within** the Garden hierarchy of staff, employees and volunteers?*

   A. What **committees** have most, if any, direct **influence** upon long-term construction plans as well as the recent small-scale Meadow Terrace project?

   B. **How does one become a member** of such a committee(s), step by step?

   C. **If such committees set of qualification** exist at all, what professional experience and qualifications are required for membership(s)?

VII. What **hard evidence** does anyone have that any part of the whole, large-scale BG construction Plans, will have on critical issues or **dangers**, such as public safety, fire road access and egress, normal and big-event traffic, parking, clearance of potential “fire ladder” brush on hillsides, and fire suppression?

   A. *For those who believe that they have or had such hard evidence, what sort of **reports** or evidence-based observations did you give to the BG management, to
the hired landscaping firm, to CEQA, EIR contractors and government officials, the county Planning and Development department, the Fire Department, and not just to the HLAC?

B. *What are the key points in your evidence* that the meadow area was NOT ever an events facility in the past? [Show the photo of the early 2007 Japanese drum troupe in front of the temporary willow castle in the meadow known as Toad Hall.]

VIII. When dealing with construction related government agencies, committees, or departments, has anyone ever received a factual, substantively related response to questions with a rationale, rather than with a boilerplate set of procedures?

REFERENCES


Technology Acceptance in Libraries: A Systemic Approach
Álvaro Quijano-Solís
El Colegio de México

Introduction

Libraries have experienced important changes within the last twenty five years. Most of them have been conciliated by the continuous change in science, technology, and economic, social and political conditions. All the organizations, seen as systems with a constant exchange within their environment, perceive this transformation from a larger presence of competitors, a constant technological innovation, the need of access to new markets, the development and commercialization of new products, and the demand to maintain financial sustainability. All of the above demand a larger acclimatization need to the conditions of such environment in order to guarantee survival and success.

According to what has been exposed and to the reading of the university library, attention areas can be pointed out as being the ones that affect its future directly:

- Tools to improve processes.
- Technology innovation and supply.
- Changes in publishing market.
- Deeper study of its community of users.
- Impact of changes in education: new models and methods.
- Knowledge management.
- Connectivity to the worldwide web of information.

Besides these attention areas, libraries are urged to revaluate and adjust their missions, functions and services as part of a reinvention which allows them to face a world where other information providers contend for users. All of these imply a change in ways of working, processes, routines, and more importantly, organizational culture. The “market” requires more competitive libraries that can foresee possible demands of users and therefore, to be more proactive in their services offers. In contrast with the passive image of a library, this presumes a major agility for the organizational development of libraries, which allows them to effectively manage information and to deliver it in due time to the user. Hence, there is a need for a larger innovation capacity in organizational culture and the use of technological infrastructure.

Being inserted in an environment growingly dominated by Internet and electronic resources, university libraries, seeing as social organizations, need to understand that their environment is mainly a communication environment where all organizations and businesses are being reinvented based on Internet, its potentials and deficiencies. Internet opens great opportunities and also sets challenges in the creation and development of learning communities that do not constrain, as mentioned before, to university library as the only information provider.
In parallel, there is a need to provide value added services in order to face the accelerated growth of Internet and the growing wireless environment. Internet, even when allows larger access to information, does not guarantee a better quality of it. As a matter of fact, although the amount of digital information available is larger every time, our expectations of assimilating and “digesting” it with reasonable effort and time have also grown. Facing such facts, users demand for a greater organization and control of information and at the same time, they demand simplicity and easiness (usability) in the access to information services, including libraries.

To sum up, more every time there is a complex environment in the information world that determines means and contents for libraries, specially the academic ones, as they are subject to additional pressures from an educational model that tends to center itself more into learning and less into teaching.

For more than a decade, several authors have insisted on the need for libraries to “read” and interpret the changes in the environment so as to remain viable and close to their mission of warranting information access and developing services according to users needs (See Stoffle, Renaud, and Veldor, 1996).

Specially, the most recent technological innovations used in academic libraries tend to emphasize qualitative improvement in order to give effective services, instead of just increasing the amount offered.

We present a case study on implications of technology acceptance in a Mexican library at El Colegio de México, a large research centre in Mexico City specializing in social sciences and humanities. The library is the largest specialized in Social Sciences in the country and it is very based in technology and with a large tradition of service to Mexican scholars. Over 100 people work there and it has a very large ratio of professional librarians to users.

Libraries and the diffusion of innovations

Innovation in information technologies do not just comprise the process of technology changes in use, but also a change in work conditions of those who make use of such technology. This socio-technical proposal (Cherns, 1976; Pollock, Higging and Murray, 1963) is supported by other studies (Commission of the European Communities [CEC], 1991; Hirschheim, 1985; Long, 1987). Since 1964, for instance, Leavitt developed his “diamond model” to present a dynamic vision of relations among the structure of an organization: duties, people, and technology. According to Leavitt, a change in one of the components implies changes in the rest of them, which presumes a need for a larger legitimization of technology within organizations. Ruel (2002) sustains that the relationship between the “spirit” of a technology (understanding “legitimization” of such technology through the application of a regulatory structure that explains and favors adequate conducts for its implementation) and the fitting level of it, by the user, is more positive if the implementation process includes changes in the internal environment of the organization.

In short, appropriation of a technology by the users will be easier if planning is guaranteed so as to enable changes in the internal environment in order to allow a “better” adjustment between technology and other organizational components.
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Acceptance and adaptation of information and communication technologies (ICT)\(^1\) are previous processes to complete assimilation of the same, which leads into the real and intensive use of new technologies; and therefore, into the productivity of the organization. Additionally, such assimilation of new technologies is a necessary condition to increase creativity in the elaboration of new products and services in libraries.

Throughout this research, technological acceptance by a user or an organization is understood as the demonstrable will to use a specific information technology for the duties it was designed and planned for at its implementation.

Considering this operational definition, we can add that technological acceptance, besides having repercussions on the use of new technologies, sets the grounds for real appropriation of such technologies and makes possible to intermediate users (librarians) to be diffusion agents of such technologies. In the case of Mexico, for example, it is common that university authorities assume that academic libraries should not only adjust to changes, but also that they must lead diffusion of change processes of information technologies inside their institutions.

Even in some university environments, authorities ask libraries to legitimize themselves as a physical space between four walls, just as we know them nowadays. The vision of virtual libraries those authorities have is of an accessible space from a desk computer, without printed books or journals. This misleading conception comes from the illusion other information providers try to sell.

This environment makes libraries and librarians to play a new role in their institutions in order to push a vital, dynamic and creative process. Goldstein (1994) assures that introduction of new technologies for information management has created an unbalanced condition in libraries and therefore, creates opportunities for organizational transformation. In fact, the degree of acceptance or rejection of a new technology by a library has an impact on its organizational culture.

In conclusion, from the library’s management point of view it is necessary to have methodological tools that allow to anticipate what technologies are adequate and above all, that allow to plan actions to face the impact this technology will have on intermediate (librarians) and final users.

**Technology acceptance in libraries**

Planning technological diffusion in library’s work environments, especially in acceptance and adaptation stages, turns into an important process to propitiate the type of technologic innovation we have been talking about. If this is not carried out with a focus where the different factors and actors that are part of the organization participate and get involved, deterioration in organizational environment\(^2\) and a decrease in productivity can be produced. The experience has proved that lack of planning in the acquisition of information and communication technologies in Mexican libraries may produce, besides what has been mentioned, a resistance to change in the routines, and a

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\(^1\) The information and communication technologies (ICT) term comprises hardware, software and telecommunication technologies. It can indicate one or more specific collections of hardware and communication technologies (Vriens, 2005).

\(^2\) The organizational environment is seen as “a collective attitude, continuously produced and reproduced in the interactions among the organization’s members”.

3
difficult adoption of regulations and standards of quality and quantity that go along with technological innovation.

These problems are related to acceptance processes of those who are in charge of implementation (planning and design of acclimatization and personalization) and technology operation (intermediate and final users). An additional consequence to these problems can be its negative effect on the organizational environment.

In contrast, when conditions favor acceptance of information and communication technologies by users (intermediate and final), these contribute to a better use of information contents, which in turn gives place to obtain improved benefits to support the academy. Otherwise, when there is resistance or sharp rejection, the user will look for alternatives (and even will show dissatisfaction) to the proposed technology and more than likely, search, organization and information selection processes will become less efficient.

In the case we are about to present, to the analysis of the original problem of low productivity and deterioration of work environment due to technology acceptance, factors must had been added in order to allow diagnosing the situation and to plan an intervention process to favor technological change through organizational learning processes, but also to consider their impact in and their casual relationship with the following aspects:

- Productivity.
- Change in processes’ routines.
- Regulations and standards of quality and quantity.

Case study

The priority purpose of the case study was to understand, as well as possible, the phenomenon, meaning the implications that non-planned technological change had in productivity and organizational environment, as well as the intervention environment created so as to better the problematic situation. The heuristics of the case study was rebuilt in order to allow future comparisons with other similar cases in academic libraries and fortuitously, to make use of the experiences from this study to other contexts or situations. As it was mentioned before, the generalization of the registered facts in the case were not looked for; however, the possibilities the case presented for the expansion of knowledge in the systemic planning of technologic change area in a specific environment were pointed out.

Data collection techniques used for the study were made upon participant observation, field notes, interviews, and semi and not-structured discussions, as well as group discussions.

Data analysis in the study, besides codification of all possible values, followed a technique of adjustment to a pattern, built over the base of theoretical proposals expressed in the model of technological cycles, similar to the quasi-experimental design

* The term ‘user’ can have a general interpretation making reference to the person using technology. However, throughout this text, references to users are specifically thought for the members of the organization called library, meaning professional librarians and technicians related to the duties in the library. This is a contrast with the concept of final user, which is the one that makes use of the library.
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of non-equivalent depending variables (Campbell, Stanley, and Gage, 1966). Also, the chronological series analysis was used, always trying to “explain” the case from the establishment of casual relationships among independent variables and the behavior of the dependant variable (for example, between the use intention and the use frequency or productivity in the model by Saga and Zmud, 1994), as it is described in Yin (1994).

The case study included the following items:

- Productivity measurement in 1999, in terms of quantity and quality standards.
- Previous evaluation, based upon data from previous step, in the application of questionnaires on organizational environment and sessions with focal groups (1999).
- Analysis of planning processes at the library from 1990 to 2003.
- Analysis of deficiencies in the planning processes of technological change at the library (1990-1999).
- Recommendations that guided further intervention (2000).
- External evaluation carried out by international experts (2002).
- SWOT-analysis (strengths-weakness- opportunities-threats) carried out by academic personnel at the library (2003).
- Continuous design and application of the intervention model (2000-2003).

In order to analyze and present the case with a certain linearity, a preliminary systemic analysis of collected information lead to a first identification of technological cycles characterized by a way of thinking and acting on the three aspects mentioned in the previous page, related to information technologies and their incorporation to the processes at the library. Authors such as Mintzberg, Raisinghani and Theoret (1976) and Poole (1981) have perceived change process from two perspectives: as a unitary sequence and as a pattern of multiple sequences. In the first case, it is assumed that the adoption process is arranged and it occurs in a lineal sequence. In the second case, it is assumed that the process is random and the phases and sequences of its occurrences cannot be predicted. Under this last assumption, we may say that the three cycles mentioned ahead articulate the phases that went along the process of technological change at the library and its management during the period from 1990 to 2003.

The characteristic that identifies each one of these three cycles is the way in which the management of the organization interpreted, by that time the role of technology in the learning processes, after a “reading” of the institutional environment and the tendencies of the technology application in academic libraries. The cycles were:

**Cycle 1: Adaptation of new technologies (1990-1994).**

Trend: To adapt and integrate new technologies into the processes and routines of the library. The main assumption was that new technologies increase productivity.
Type of planning: Centralized and deductive.

**Cycle 2: Learning and group work (1995-2000).**

Trend: To increase collective knowledge through group work and communities of practice, around concrete problems. An assumption was that collective learning and group work reduce stress caused by integration of new technologies into the processes and duties at the BDCV. Another assumption was that group work reduces adapting time and increases the frequency of use of technologies.

Type of planning: Participative

**Cycle 3: Appropriation: generative learning (2000-2003).**

Trend: To create knowledge related to technology use. The assumption was that learning on the use of technologies is a formal and social process of teaching-learning, which is susceptible to being improved through research-action, reflection and permanent questioning.

Type of planning: Collaborative orientation for the development of projects.

In the cycles description it is evident that the increase in the complexity and use of more specialized tools to plan the change and to adapt and integrate planning into the processes and services at the library, with the consequent complexity of utilized routines and regulations.

The identification of these cycles allowed to extract the main characteristics of each one of them, the learning obtained throughout these years and the main conclusions that give support to organizational change outlined in 1999; specially, in favoring group work and delegation of the decision making process.

**Diagnosis and intervention**

In the Saga and Zmud (1994) model of technological acceptance, the variables that have a more direct influence on the use frequency are: the beliefs of personnel on the effectiveness, utility and accessibility of the new technology, as well as the attitudes towards the use and the use intentions.

In turn, these variables are influenced by others such as the participation of user, the previous knowledge and the intervention of the management. In our case, the intervention of the management was focused on three factors:

- Participation of academic personnel in the planning processes of technological change.
- The consideration of the academic personnel’s perceptions in charge of adaptation processes (routinization and normalization).
- Previous knowledge of personnel on information technology and learning processes.

One of the questions that came up throughout the study made reference to the degree of whether productivity and expectations which the management had about it had been affected by the different shapes the professional work from personnel took and the flow of their activities, as a result from changes in technologies. Differentiation of personnel according to their abilities, as well as the individual or collaborative way of working had to be incorporated in the analysis as essential elements that could contribute to
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adapting new technologies, whether the learning curve was slower or faster. The study found that these elements explained technological acceptance as a whole and that specific characteristics of every technology implemented resulted in being marginal at the time of explaining changes in productivity. In other words, contextual aspects turned out to be more critical than technical aspects of the library automation system adopted.

In order to help the understanding of the case studied and the different factors that shape it, the following graphic:

**Figure 1 Case’s environment**

This graphic shows those factors, which being part of a non-transactional environment are; however, very important for the library: the tendencies in information and communication technologies and in educational models.
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From a systemic perspective, social organizations, such as the library, are composed of actors who interpret each other as members of this organization and such mutual acknowledgement allows the organization to function as a macro level system, with auto-organization properties, as an autopoietic social system. (Maturana and Varela, 1980; Luhmann, 1996; Scott, 2002).

A major systemic property is the resistance to disturbances introduced by changes in the environment, which fertilizes the ground for planning processes that give shape to the organization in order to intervene it through micro-processes that allow change. Such micro-processes, as explained in technological change plan, must make people involved to participate in a collective learning based on reflection and action, even if the group of strategies and policies that guide change are often given from the highest levels of the organization.

However, the most common situation in the case study was the one that came up during the studied period; it consisted of integrating policies, strategies and details of planning as part of the change process itself. Therefore, intervention must begin from the group’s understanding that the need for a change is a continuous educational process about the particularities of change management, which in turn is assumed as a change in the organizational culture (Scott, 2002).

In the middle of 1999, based on the results from interviews made to academic personnel, it was determined that it was necessary to modify the work structure. It was considered that the main goal was to reinforce individual capabilities and productivity starting from group work, as well as to impel self-management capacity and collaboration among parties. From that moment, different group works were generated, under the assumption that the organization was mature to learn, share knowledge and establish communities of practice. (Wenger et al., 2002).

The following groups were formed for the everyday operation of the library:

- Selection.
- Thematic Cataloging.
- Descriptive Cataloging.
- Validation of Authorities.
- Attention to Users.
- Management.

Furthermore, starting in 2000, the following transversal groups were created:

Substantive programs:

- Collection Development Program.
- Electronic Resources Access Program.
- Collection Preservation Program.
- Bibliographic Control Program.
- Authorities Control Program.
- User Instruction Program.
Work groups had a leader, who was rotated every three months. Work groups were integrated to the co-ordinations and leaned on general regulations, which were elaborated for their functioning, and that included the following aspects:

- Members.
- Group leaders.
- Scope of group action.
- Responsibilities of group leader.
- Responsibilities of group members.
- Responsibilities of Coordinator.

It is important to highlight that groups were formed only by members from the academic personnel, and that one person could be part of one or more groups, regardless of the Department. According to that, one person could be group leader and at the same time, part of another group. In the hierarchy line, the same person could depend of one or more co-ordinations; even of the Direction.

This type of organization required an information flow from each one of the groups and co-ordinations. Due to that, group leaders had to carry out communicative processes inside and outside the work groups. Figure 2 presents the functional organizational chart of work groups, existing since 2000.
The selection of members of each one of the groups was done according to capacities detected as strengths for each member.

Conclusions of the case study

Throughout the three cycles established a priori, the case studied sets a pattern of regularity among the planning and technological change management factors. Productivity and environment kept acceptable levels within the first two technological cycles and added value was increased in processes and services at the library. However, it is at the end of the last cycle that productivity decreased and a perception of a disturbed organizational climate was generated. This suggested a need to adapt a planning process to the forthcoming technological change by starting with an organizational restructuration and a major “leveling” of structure, favoring work groups in order to promote future creation of communities of practice (Wenger et al., 2002), a goal that was not completed during the period studied.

By 2002, functions of the direction and co-ordinations were oriented towards work group and towards shared decision making. In the Collection Development Coordination, for example, one of the functions was to “carry out, with collaboration from bibliographers [from other department], the discarding of books that [were] not of
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interest for the collection development, according to policies established” (BDCV, 2002).

It is in the Data Base Access Coordination where it can be observed at the end of the period studied that stronger learning allowed to orientate work to knowledge management in relation to information technologies, specially in the duties the group set forth in order to facilitate access to collections, apply international regulations for information transference and exchange, and in the access to digital documents reports. In this coordination, work group was extended towards the rest of the personnel, to include support staff.

The intervention done in 1999 looked to favor restructuring of the organizational climate and the return of productivity indicators to levels observed before diagnosis. In the recommendations made to the Direction by academic personnel in 1999, it was imperative to change styles of organizing and managing work at the BDCV so as to stop deterioration of work relationships among personnel. The hypothesis used for the intervention was that if changes were not carried out, the environment would worsen and an abrupt change of management would have been imperative. Timely intervention facilitated that such change of management would have been planned to happen at the end of 2003.

The external evaluation carried out in 2002 found that the structure and environment have been strengthened; and they were solid, even though they needed improvement, especially in the relationships among administrative personnel. Also, it was pointed out a need to make additional adjustments to keep the prestigious level at the library.

Determination of weaknesses and strengths, carried out in 2003 as part of the strategic planning of El Colegio, gave less optimistic results in relation to the organizational environment. Academic personnel kept sensing work environment as an organizational weakness, but it had less force as the one manifested in 1999. It was not possible to conclude whether the environment was improved substantially at the end or not, but it is clear that it did not worsen; it was just less suffocating as it was perceived towards the end of the century.

Much innovation has been produced at the library since then, under a new administration that began functions at the beginning of 2004, and many of the observations from external evaluators, allowing the building of stronger foundations for a knowledge management philosophy that begins to bear fruits, by voicing results in the recent Masters in Library Science Program that El Colegio began in 2004.

The analysis of documents from the period allow to verify that a process of continuous improvement has been developed, supported by careful planning, which has allowed to soothe possible decreases in productivity and to preserve work environment.

The change to favor work groups has been the detonator for other changes in the organizational culture, particularly the one that gave place to the possibility to value the chance to move forward in the development of academic personnel as very important, a need highlighted by the postgraduate program in library science that the BDCV develops since 2004.
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CONCLUSIONS

This work reached its objective to search for the possibility to plan acceptance and adaptation processes of information technologies and organizational change. During such process, the questions posed at the beginning were able to be answered.

It was found that appropriation of a technology by users will be easier if planning is guaranteed so as to enable changes in the internal environment in order to favor a “better” adjustment among that technology and the other organizational components.

It was also found that productivity in an academic library can be maintained during technological changes with an adequate prevision of learning factors that must be incorporated in parallel to the implementation, such as changes in routines of processes and the strengthening regulations and standards of quantity and quality. Also, work group must be favored, as a collective learning mechanism on the implementation problems. Curves of this learning are multiple and keep a complex dynamism, as technological change in the ICT used by libraries assumes simultaneous acceptance and adoption of different technologies that interrelate and demand for processes that do not only correct mistakes, but also that favor work group and organizational knowledge.

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OPERATING PRINCIPLE OF THE UNI-VERSITY

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ABSTRACT

Ludwig von Bertalanffy, in the very last sentence of the last chapter of his book *General System Theory* wrote:

“Note 7. Notice the theological motive in Leibniz’s invention of the binary system. It represented Creation since any number can be produced by a combination of ‘something’ (1) and ‘nothing’ (0). But has this antithesis metaphysical reality, or is it but an expression of linguistic habits of the mode of action of our nervous system? ” (Bertalanffy 1969)

It is posited in this paper that such a principle does in fact have a metaphysical reality. It exists not only in the conceptual schemes of humankind as a fundamental principle of that conceptual process, “an expression of linguistic habits…” but also in nature as the primary principle of structural co-operation a.k.a. synergy or the integrative system.

In this paper I will discuss the complementary (a.k.a. system) as an artifact of our conceptualization process as well as provide examples of the metaphysical reality by which nature works together at all levels of existence. This principle is not to be confused with a “Theory of Everything” which is, in principle, impossible because, in short, any thing cannot be everything. However, there can be and is a principle of how everything works as exemplified in the concept of a minimal system. (Schwarz 1995) In short, there is no "General System Theory" but there is a "General System Principle“. That principle stated implicitly is “working together.”

Keywords: Theory of Everything, Principle of Everything, Operating Principle, Universal Principle, Principle of Conceptualization, General System Theory.

INTRODUCTION

The quest for the unifying principle of the Universe has been with us ever since we could wonder in awe at the sun and stars in the sky. This drive exists because there is in fact a unifying principle. If there were no such principle, then the esoteric thoughts of great thinkers given to us throughout the history of mankind would eventually be revealed as false. This falsification has not happened. Instead the search continues. But is this principle something unknown remaining to be yet discovered? For example, complexity science’s search for the Ur principle? Or is it already known?
The quest to grasp the nature of the Universe has been around in recorded history since the Chinese formulated their Yin/Yang concept to describe it in the I Ching around 3000 B.C.. Since then, poets, philosophers and scientists proposed dozens of versions. It was picked up in the Father and Mother in the Kabala, The Subject, Object and Fohat by Blavatski, by the Opposites of Heraclites, The Love and Hate from Empedocles, the Coincidentia Oppositorum of Nicholas of Cuza, the Binary system of Leibniz, the binary asymmetrical relationships of Salk, the first, second and thirdness of Peirce, and, nowadays, in Bertalanffy’s elements in standing relationship philosophy of general systemology.

BACKGROUND

In 1980, Scientific American published an article by Gerard t'Hooft in which he describes the theories of the four forces of nature and their general form.

"A long standing ambition of physicists is to construct a single master theory that would incorporate all the known forces. One imagines that such a theory would reveal some deep connection between the various forces while accounting for their apparent diversity. Such an unification has not been attained, but in recent years some progress may have been made...What may ultimately prove more important, all four forces are now described by means of theories that have the same general form. Thus if physicists have yet to find a single key that fits all the known locks, at least all the needed keys can be cut from the same blank." (t'Hooft 1980)

Perhaps the best survey of such a quest is given by John Barrow in his book *Theories of Everything*. I have excerpted several of his key statements and they read:

"...a theory of everything which will unite all the laws of nature into a single expression... an abbreviated representation of the logic behind the universe’s properties...a single coherent framework...an encapsulation of all the laws of nature...a simple and single representation...the ultimate directory...an independent prescription which appeals to simplicity, naturalness and economy...a union of perfect and unique intercompatibility ... a general principle ... which can be applied in a variety of different situations without becoming embroiled in their peculiarities...Perhaps there exist a whole set of basic rules about the development of complexity which reduce to some of our simpler laws of nature in situations where the level of complexity is essential nil. If such rules do exist, then they are not like the laws which the particle physicists seek. But is there any evidence that such principles exist? A collection of $10^{27}$ protons, neutrons and electrons may be all that a desktop computer is at some level, but clearly the way in which those sub-atomic particles are put together, is what distinguishes the computer from a crowd of $10^{27}$ separate sub-atomic particles. ...The question of the existence of a "secret of the Universe" amounts to discovering whether there is some deep principle from which all other knowledge of the physical world follows...” (Barrow 1991)
So the question is whether or not such a principle can be found, and indeed it has as a general form. In Jonas Salk’s book, *The Anatomy of Reality*, he writes

"It appears that all units of reality are comprised of two basic elements in an asymmetrical binary relationship in dynamic interaction...As noted above, one of the basic ideas that underlies my thinking, one of the images I have in mind when I contemplate the universe, is that it is constructed upon a simple pattern of order that may be seen in any and all phenomena, no matter how complex. The simple pattern is that of a binary relationship, recognized in a binary system. The implication here is that everything in nature, everything in the universe, is composed of networks of two elements, or two parts in functional relationship to each other...The most fundamental phenomenon in the universe is relationship." (Salk 1983)

What Salk is talking about is the complementary relationship as a general form. We can fast-forward a little and jump to one of the conclusions reached by quantum physicists in the book *The Conscious Universe*:

“We will also advance the hypothesis that the epistemological situation we are obliged to confront in a quantum mechanical universe, in which non-locality must now be viewed as a fundamental fact of nature, provides a new basis for understanding the ability of the human brain to construct symbol systems, or symbolic representations of reality. Drawing extensively on Niel Bohr's definition of the logical framework of complementarity, which we regard as fundamental to understanding the actual character of physical reality in a quantum mechanical universe, we will advance and attempt to support the view that complementarity is the most fundamental dynamic in our conscious constructions of reality in both ordinary and mathematical language systems. If this thesis is correct, it provides a more reasonable and self-consistent explanation than physical scientists have developed thus far as to why the language of mathematics, or the language of mathematical physics, is more "privileged" in its ability to uncover the dynamics of physical reality than is ordinary language. And it could also relieve much of the obvious "angst" that has apparently been occasioned by the rather widespread conviction among humanists and social scientists that all of us are locked, as Nietzsche put it, in the "prison house" of our linguistically-based constructions of reality with no real or necessary connection between subjective reality and external reality. The most radical hypothesis advanced here is, however, more narrowly scientific. That hypothesis is that since complementarities has been a primary feature in every physical theory advanced in mathematical physics beginning with the Special Theory of Relativity in 1905, and since complementarity can also be shown to be an emergent property or dynamic in the life of the evolving universe at increasingly larger scales and times, the future advances in physical theory in cosmology, or in the study of the origins and evolution of the entire universe, will also feature complementary constructs." (Kafatos 1990)
Such a principle is not a modern invention, Lao Zhu writes in the Tao te Ching:

In the beginning was the Tao
    The Tao begot One
    One begot Two
    Two begot Three
The Three begot the Ten Thousand Things
    The Ten Thousand Things embrace Yin and express Yang
Harmony is achieved by combining these forces  (Lao Tzu 1974)

It is assumed in this paper that there is such a principle and that it is well known, but is there a theory?

Barrow concludes that finding a Theory of Everything would be like saying everything, which would be saying nothing at all. There is a problem, after all, with such a "theory". In order for science to formulate a Theory of Everything, it will have to do so in a specific way. It would have to say “something.” This is the catch; the Theory of Everything cannot be a specific way, it cannot say something, even everything, because to do so would by definition exclude what is not something. Ultimately, there cannot be a scientific THEORY of Everything. The subtle error in logic, the assumption that the unifying principle can be stated as a theory, is fatal.

Science and Philosophy

Much ado has been made about the translated word “theory”, so that there are two ways of interpreting the phrase “General System Theory. One is a “general system” theory and the other is a general “theory of systems”. The former implies a single theory that applies to all systems in general, whereas the latter implies a general theory of system principles. Considerable resistance to a single universal general theory has emerged, and the mainstream systemic view has gravitated to a more plausible “general theory of system aspects.” This paper posits that both views are valid, but not when taken as a strictly scientific “theory”. It is proposed that there is in fact both a general system principle and there are several additional principles composing a theory of systems.

So the controversy around the translation of Bertalanffy’s book is actually a confusion of terms which has been recently made moot by the translation of general system theory into General Systemology by David Pouvreau and Manfred Drack in their article On the History of Ludwig von Bertalanffy’s “General Systemology” and its Relationship to Cybernetics (Drack 2007).

Philosophy and the General

To make a distinction between philosophy and science clear, consider, for example, the Pythagorean theorem. In its general form, \( A^2+B^2=C^2 \), it applies to all right triangles. The philosophical expression is a general expression. However, in its specific form, the form
that a scientist would use, it applies only to a specific situation, say: \(3^2 + 4^2 = 5^2\). This is why scientific formulations, in principle, cannot be wholly composed of generals. Science cannot use the general formulation in that form in any useful way. All science can do, as it is defined in this paper, is find a specific application of the general principle. It is up to the philosophy of science to make it general. It follows therefore, that the supposed Theory of Everything cannot by itself be a theory. However, the impossibility of a Theory of Everything does not imply the impossibility of a Principle of Everything. We can say that all red is a color, but we cannot say that all color is red.

The unifying principle is not to be found in some new science of complexity, or is it a mysterious esoteric secret, instead it can be found in the science of simplicity, but not just any simplicity. A universal principle would have to also describe/enable the simplest form if it were to apply universally. But only the simplest can describe itself. For the same reasons, a principle of complexity, if there is a fundamental principle of complexity to be found, will likewise be found in the simplest form of complexity. Therefore if there is principle of complexity, such as the Ur principle, it will necessarily be the simplest complexity, e.g., a minimal system. A system, by any (systemic) definition, is a complex. Ironically, a “complex system” is oxymoronic. The simplest complex system is a system.

Simple but not too Simple

Surprisingly, simplicity is not as simple as some would think. I was led to this not-too-simple principle because I had used a very simple model to explain a profound insight I had. An insight that was new to me. This turned out to be a great advantage. I used an ordinary coin to model my insight: that the two sides make up a whole coin. That comes pretty close to how I initially modeled my insight. Here is where the story took an ironic fork in the road. I already knew that! In fact, I surmised, everyone knows there are two sides of every coin! So what? But this insight felt “new” to me, so I figured there must be something else, there must be more than just two sides of every coin. And shortly I realized there is the inside that hold the two outsides together -- a third side of every coin. There are three sides of every coin. At first I thought that was new enough, indeed it would take five years before I found a similar formulation (the Hegelian Triad). In the end, it is an old principle, even older than the Triad which turns out to be a two sided coin.

It is often believed that one is the smallest quantity. At first glance, any concept that we create in our mind seems to start with one single concept. Let’s say we start with a point. A point seems like it is a single point. It would seem that a single point is one point. But when we go deeper into our conceptualizing, and examine more fully what we have actually created, we find that we, in our creation of a single point, have done so by isolating it from everything else and in doing that have also created the anti-point. So our creation of a single point is a creation of two concepts, the point and the anti-point. Up means, also, down. But is that all there is to it? No, because when we isolated the point from the anti-point we effectively eliminated or hid their relationship that once held them together as a whole. We have transformed what was three into one, and then assumed that the one is all there is to it. It is in this way that the Hegelian Triad denoting Thesis>Antithesis>Synthesis is incomplete. It is obvious that there must be a relationship
between Thesis and Antithesis before a Synthesis can emerge. A movement from a Thesis to an Antithesis is not a Synthesis.

It is proposed in this paper that the simplest concept of a “part” is not one part or even two parts but three conceptual parts. That is to say if we divide anything into parts we will have divided it into a minimum of three parts. Obviously, one part is not a part, it is the whole. So, also obviously, one part means, by definition as described above, two parts. Not so obvious, two parts have to be in a relationship to be a whole. That adds up to three conceptual parts. The least number of parts composing a whole is three. And it is this very part that we have eliminated that true existence resides.

It is further proposed that these three aspects of a whole are archetypal; they are implicit in all conceptual formulations. It may follow then, that these three archetypal concepts, the “This” and the “That” and their “relationship” found in any conceptualization process, forms a primary or first principle of conceptualization. Is there more?

PART TWO

The Operating Principle of the Uni-versity

As a concept, this principle is not something that is mysterious or even profound. It is, after all, just a way of looking at things. A perspective. What may be profound is whether or not such a principle, in the words of Bertalanffy, has a “metaphysical reality”? I am suggesting that it does in fact exist as a reality in nature, that it has an existence independent of human thought, and is not at all mysterious. It is, however, not trivial either.

In this section I will be using DNA as an operational example of how and where the principle is at work at a fundamental biological level. This principle will be presented here as a philosophical principle, and therefore will not be bound to the normal scientific criterion of a presentation of a scientific theory. Specifically, while particular examples will be presented, these particulars are to be regarded as philosophical positions and thus will not be presented in a strictly quantitative manner.

As review, the principle being shown here is first of all the simplest conceptual principle. In any concept a distinction is made between one concept and the other non-concept. No concept can exist without this distinction. Even if we show a single point, it is presented as a point, and by doing so we also have presented that which the point is not. So in any conceptual system we have at least two primary concepts. The concept itself and the anticoncept. This much is obvious. What is not obvious and what is presented as “new” or at least “unique” is the relationship between the point and the anti-point. However in most cases what is obvious is also hidden. When we remove the point from the whole, we have also removed the relationship between the point and the Whole that prior to the separation held them together as a single whole. When we separate the whole into parts we eliminate the relationships between the parts. Our analysis then, given only the two separated parts, proceeds without the relationships as if they do not exist. Therefore, in
any conceptual system, we can identify THREE (3) primary elements, the concept, the anti-concept and their relationship. (This is similar if not identical to Peirce’s First, Second and Thirdness approach.)

So, it is clear that the first division of anything conceptual will be a division into three elements (two entities and one relationship). The question now becomes what has nature done with this. Nature is defined here for our purposes as the natural process. (An interesting experiment that might be conducted is to try to cut a pie into three or more “pieces” with one single slice.”

The Blueprint of Life

We will now discuss Life. This discussion will be confined to Eukaryotic organisms, organisms having a nucleus. A living multicellular organism begins with the unification of an egg cell and a sperm. Both the egg and the sperm contain a single strand of DNA. An egg is a complete cell (the largest cell in the human) whereas the sperm is only a single strand DNA with a protein coat (the smallest cell in the human body). Following is a description of the organism according to the uni-versity principle being presented in this paper. Notice the word “uni-versity” which is meant to contain both the unity and the diversity of an organism.

First a Review

In most organisms, DNA is formed as a very long and very narrow double-helix formation of two DNA strands coiled around each other in a head-to-toe "antiparallel" orientation. The strands provide structural support for a complementary pair of bases located inbetween the strands (a base pair is like a letter of a genetic word). A sequence of three base pairs forms a codon (a DNA word) on the DNA strand that encodes the information for one amino acid residue. A series of codons, and associated start/stop codons, (a DNA sentence or gene) forms the genetic code for the selection of particular amino acids and their specific arrangement necessary for the assembly of a particular protein molecule. The protein molecules, as many as 20,000 different types, are used in the cell, or are transported, often via small containers (vesicles), to other areas of the organism.

Each single strand of DNA is a long biopolymer comprised of repeating units called nucleotides. A nucleotide is a base linked to a sugar and phosphate group which form a sugar/phosphate backbone. Attached to each sugar molecule (deoxyribose) is one of the four "bases"; Adenine (A), Thymine (T), Guanine (G) or Cytosine (C).

Double stranded DNA is formed by a weak hydrogen bond between the bases holding the nucleotides together. Each base is a structural complement of its opposing base, so both together form the base pair. The complementarity base pairs, A&T, C&G, are identical in size and shape and only one of the four arrangements - TA, AT, GC and CG, will fit between the backbones of double stranded DNA; e.g., adenine always pairs with thymine and guanine always pairs with cytosine. This "complementarity", is at work in all DNA
Operating Principle of The Uni-Versity

functions, and makes it possible for DNA to be copied and repaired relatively easily, while accurately preserving its information content. Thus it forms the basis of semi-conservative DNA replication.

Nuclear DNA is organized and stored as chromosomes within the nucleus. The nucleus is a double membrane separating the DNA from the cytoplasm of the cell enabling certain processing to occur prior to protein synthesis. Each chromosome holds hundreds or thousands of genes. A gene can be described in different ways but in general can be thought of as a whole unit of genetic information.

At conception, the male sperm, (a half stranded DNA with a protein coat), and female ovum, (an unfertilized egg also containing a single strand of DNA), each contribute 23 chromosomes for a total of 46 chromosomes in the human fertilized embryo. The total sum of chromosomes is called the kayrotype in eukaryotes (organisms such as plants, yeasts and animals whose cells have a nucleus).

The entire DNA sequence of genes as a whole in any organism is called its genome. The genome provides the necessary genetic instructions to produce the phenotype, the outward physical manifestation of an organism, as well as the necessary processes involved in the replication of nuclear DNA.

It is the complementary structure of DNA which enables it to function as a template for translating the genetic code and the assembly of the proteins. This complementary structure also enables the double stranded DNA to be separated and replicated as two exact duplicates during cell division (replication). Nobel laureate Arthur Kornberg explains, "Complementarity has come to explain transcription and translation and thus the entire sequence of events in the expression of genetic functions. It is also the basis for exchange of DNA segments between chromosomes in several forms of recombination." (Kornberg 1980)

The Complementary

This is a simple but accurate mainstream description of the DNA process. Now we will look at how these elements and processes form groups, in particular a this and that group. To do this I will be using groups or systemic units or holons as conceptual entities.

A complementary process (synergy) is a process of working together. Together implies more than one. Working implies action. Working together implies at least two working together. In the following example I will show how the DNA process is composed throughout the entire process of two somethings working together.

A Translation

For this explanation I will be using “WT” to denote the relationship between the pairs. This relationship is contextual and depends on the situation being described. It is not the purpose of this description to ascertain what WT is, only that it is present.
The first grouping is male and female and their relationship. This grouping is obvious and applies to most living organisms.

(Male/Female)WT <=> Marriage

This relationship, if loving, results in a unification

(Sperm/Ovum)WT <=> Zygote

The significant process upon the integration of the sperm and egg is a union of single stranded DNA from the female egg and male sperm each, forming one double stranded DNA molecule.

(SSDNA/SSDNA)WT <=> DNA molecule

Double strands, as a unified object, consists of two strands each constructed from a repeating series of a sugar molecule and a phosphate molecule

(Sugar/phosphate)WT <=> single DNA backbone

Each of the strands are bonded to the other by the complementary bonds of the bases forming the backbone of DNA

(Strand/antiparallel strand) WT<=> double stranded backbone

Bonded to the sugar molecule is one of four different types of bases

(Sugar/base) WT <=> nucleoside

Two of the bases are complementary to two other bases

(T/A)WT <=> base pair

(C/G)WT <=> base pair

The DNA molecule is wound around a protein and further folded into a chromosome.

(DNA/Histones)WT <=> chromosome

Replication is achieved by the transcription of a sequence of codons to a complementary mRNA

(SSDNA/mRNA)WT <=> isolated mRNA

The mRNA is a complementray of the sequenced codons.
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(Guanine/Cytosine)WT <=> Base pair

(Anadine/Thymine)WT <=> Base Pair

Amino acids The amino acid is a ring of atoms with a tail. All amino acids have an identical ring but different tails. So here we have a common “This” which works together with a different “That” with the result if 21 different amino acids.

(Circle/tail)WT <= > Amino acid

Amino acid itself is composed of a amine group and a carboxylic acid group hence amino acid/

(Amine group/Carboxylic acid group)WT <= > Amino acid

Translation the mRNA moves the transcribed sequence to a Ribosome . The ribosome is constructed of a small and a large part. The ribosome is assembled within the nucleus as a small and a large unit, a this and a that, and then is moved to the cytoplasm.

(Small ribosome part/big ribosome part)WT <=> ribosome

The ribosome reads the sequences and connects the appropriate amino acid one at a time, it connects a this with a that. The ribosome is a biomachine which translates the tRNA sequence of amino acids into a protein one step at a time.

(amino acid string/amino acid)WT <=> incomplete protein string

An enzyme connects to a this molecule and also connects to the other that molecule. In all cases, an integration of molecules requires the enzyme action to assemble the molecules or proteins. By connecting the molecules together eventually a protein is formed. When the ribosome is assembling the protein it does it by assembling one single amino acid to the partial string one at a time. So in all cases it is assembling a this to a that. It should be noted that a particular RNA may have multiple ribosomes moving along its length at a time. And that there may be multiple ribosomes acting on multiple mRNA.

(molecule/molecule)enzyme <= > large molecule

The reverse process of disassembling proteins in order to obtain energy also works by enzyme action.

Molecules <= > enzyme(molecule/molecule) <= > energy

And in all of these cases, the addition or removal is a binary process of a this and a that working together.

(This molecule/That molecule)WT <= > complete molecule
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What is have just described in the entire DNA process using the same general form. The same general form that t’Hooft used to describe the Four Forces of nature, and the same general form that physicists use in their theories, and the same general form used in many archetypal principles.

Exceptions to the Rule

It has been pointed out that there are tens of thousands of process occurring in a typical cell and that not all of them are as simple as this principle would suggest. This is true, but what is being posited here is that all of them are derived from this simple principle. Every combination of molecules or amino acids or proteins occurs by means of enzymes. An enzyme works by attaching to one part and the other part. This is also true of combinations that are being separated. It is suggested here that every one of these processes occurs as a binary process, that is to say every process is an integration of a this and a that. The fact that there are millions of these processes occurring at any given moment does not invalidate the principle itself.

It has been suggested that there are many cases where more than two units are involved. For example there are thousands if not millions of processes going on in a typical cell. I do not wish to suggest that this is not true. What I would suggest it that each of these thousands of processes are working according to this principle. A good example is cell membrane. Cell membrane is made of two molecules back to back repeated the appropriate number of times.

\[(\text{molecule/molecule})\text{WT} \leq \Rightarrow \text{membrane}\]

Additional Reading

In addition to this formulation, a scientific notation was invented by the author and published in the journal *Scientific Inquiry* (Mandel 2006)

CONCLUSIONS

What I have shown here is that the entire process of DNA structure, transcription, replication and protein construction is accomplished by the complementary process of taking a this, and with the aid of an enzyme, combining with a that ending with a new whole. And while there may be tens of thousands if not millions of simultaneous processes occurring in any single cell, all of them follow this simple scheme.

All molecular process involving both the integration and/or differentiating involve an enzyme. The enzyme works by making a connection to a this and then a connection to a that and then bringing them together. And it does this one at a time.

The purpose of this demonstration is to show that the foundational structures in all living being are fundamentally a complementary process. There is little reason to suspect that this complementary process does not follow through in all the processes involved in
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living organisms. If this is eventually shown to be true, then it is clear that this complementary process, the assymetrical binary system, forms a universal principle.

To use this principle in any way you want, just clap your hands. Think of that as the general syntax. Now add your own semantics, what do you hold in your left hand and what do you hold in your right hand, Bring them together.

It is as Kafatos and Nadeau writes: a skeleton key from which all other keys could be made.

For Discussion

It is not within the scope of this paper to speculate on the evolution of all living beings. But it is clear to this author that such a scheme, which is really a simple system, is the evolutionary principle by which all life emerges. The alternative view, survival of the fittest by natural selection, is sterile. Natural selection is “after the fact” and doesn’t kick in until after the evolutionary change has taken place. When pinned down, advocates of the selection viewpoint propose that the preceding evolutionary change was a random mutation, an accident. But there are far too many changes requiring multiple simultaneous changes to explain by means of an accident. Survival of the fittest has led to a notion that the Universe operates by competition, that harmony is achieved by the victory of one over the other. There is nothing in the human body that operates accidently or by means of competition outside of cancer and dis-ease. It should be obvious, as evidenced by the first steps in the creation and maintenance of all living organisms that the primary evolutionary principle is working together, what is called here, the complementary system. The compounding of elements into something new is basic to systems, and it is this principle that the Universe works by. From the proton and electron in relationship to hydrogen and oxygen in relationship, to the sperm and egg in relationship, to the man and woman in relationship, to the child and the Universe in relationship, working together is the primary operating principle of the Uni-versity. The Unity found in all diversity.

A “System” is a Family…

If we want to change the world in order to improve it, we can do so by changing the way we look at the world. This much is obvious to anyone who has fallen in love. It is often touted in systems thinking that it is necessary to look at the whole picture, and then it is added that the whole picture looks different than merely adding up the parts. And while this may certainly be true, it is not all that systemics has to offer. Indeed, many will say it is obvious that all components of a system need be considered, so what is new? Well, there is much more to a system than just the components making up a whole system.

Ludwig von Bertalanffy writes:

"Compared to the analytical procedure of classical science with resolution into component elements and one-way or linear causality as basic category, the
I would like to bring attention to “new categories of interaction, transaction…” Permit me to use a more general term “relationship” What is a relationship? Is a relationship a kind of entity that we can name? I submit that a relationship is not an entity but an action, a doing. Take Love for example, what is love? We really haven’t figured out the answer to that question because to define love is to define a thing. And apparently we haven’t found the thing we call “love.” But what if we change the thing to an action and then ask “what is loving?” Ah, suddenly we know. The same goes for life? What is life? Well, what is living?

As we all know, the human is among the most complex beings we know of. So when we talk of a human being we are talking about complex systems. It is interesting to note that the language ordinarily used in the human complex system is actually very systemic. So much so that how we talk about humans can be used as a model for how we need to talk about other relationships of the mundane kind. Let’s go back to our most complex human being language. Imagine two persons. There are two ways in the language of mankind that these two persons can be described by our language. We can call them Jim and Mary, we can name them as if they were an entity. But there is another way we can name them, we can name them father and mother. It is their relationship that makes them a father and mother. If we look at a whole collection of names like Bill, Dave, Mike, June, Jill, Joan, We can surmise that they are human beings but not very much more than that. We don’t know from their name how old they are, or what they do or how they are related to each other. But look what happens when we give them relational names like father, son, uncle, cousin, daughter, friend, stranger, neighbor. When we name them in terms of their relationships we know a whole lot more about each of them and what they do.

And so it is with our favorite word “system.” When we think of a system in terms of a thing we run into all kinds of problems. Are we talking about that system or are we talking about “my system” or “your system”? So the word system, by itself, is sterile too. It has no intrinsic meaning. Or it has so many meanings that it become meaningless. But look at what happens when we name a system in terms of human relationships, in terms of what a system does. We find we can call a system a family. A system is a family. A family is a system.

And it is the same way with things. We can give things names but those names are sterile. What is more important and meaningful is what those things are doing. What they are in terms of their relationships.

So it is not the concepts that make up our reality, rather it is how those concepts work together.

Erich Jantsch wrote in his book Self Organizing Universe:

**Erich Jantsch wrote in his book Self Organizing Universe:**
“In a true system...not all macroscopic properties follow from the properties of components and combinations. Macroscopic properties often do not result from static structures, but from dynamic interactions playing both within the system and between the system and its environment...A human being falling in love -- perhaps only once in a lifetime -- changes the life of the community of which he or she is a part. Such considerations already hint at the fact that a systemic view of necessity leads to a dynamic perspective. Quite generally, a system becomes observable and definable as a system through its interactions. (Jantsch 1980)

Note: One can observe what a system does by observing the Gestalt figure below with a focus on the white or a focus on the black.

“That’s All Folks”

References


The System of Systems Processes

Brian Hilton

Let there be nothing\(^1\), no matter and no energy, and make the following two conjectures.

Conjecture 1 (the McIntyre Conjecture)

All processes are emergent from flow in a moebius field.

Conjecture 2\(^2\):

Linked slow and fast processes are necessary for boundaries and so structure and form and these degenerate in the limit to produce systemic emergent hierarchies and terminations.

If Conjectures 1 and 2 are true we have necessary and sufficient conditions for the holistic universe we can sense of infinitely diverse interconnected forms.

If one uses the mathematics of Rene Thom’s highly regarded\(^3\) “Structural Stability and Morphogenesis” and treat the above as axioms one gets this result as their consequence. The diverse observed universe is an inevitable consequence of any flow in a moebius field. This field by definition, and observationally by conjecture, has only one side and one edge and must exist in three dimensions.

\(^1\) This only makes sense after you get to the point when it is worth reading footnote 4 but it is very profound and very hard to get your head around but it contains everything.

\(^2\) Hypothetical Conjecture 2(???)

All linkage propositions are isomorphies of the following 3.

Linked slow and fast processes are sufficient for boundaries and so structure and form.

Linked slow and fast process when dominated by the slow process leads to the degeneracy of boundaries and to the termination of structure and form, death.

Linked slow and fast process when dominated by the fast process leads to the “generacy” of new boundaries and so to the emergence of structures and forms, hierarchy.

However we only need one linkage proposition as 2 and 3 are degenerate cases of 1.

\(^3\) NB. The only sustained criticisms made of this were not of Thom’s work per se but of naïve scientific and non-scientific applications of it.
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Let us consider a Möbius field of half-width $w$ and a mid-circle radius $R$ and zero height $z = 0$. Parametrically in time and on its own surface this has the following analytical expression

$$x = [R + s \cos \left(\frac{1}{2} \cdot t\right)] \cos t$$  \hspace{1cm} (1)

$$y = [R + s \cos \left(\frac{1}{2} \cdot t\right)] \sin t$$  \hspace{1cm} (2)

$$z = s \sin \left(\frac{1}{2} \cdot t\right),$$ \hspace{1cm} (3)

for $s \in [-w, w]$ and $t \in [0, 2\pi]$.

The above function implies a differential in speed between any two points in the field. This makes it inevitable that it must develop a singularity. This will cause it to split along its length. This is the only means to reconcile the turbulence the singularity produces. This process will continue ad infinitum but this universe will always remain only one field and only one thing\(^4\).

The first split produces a mobius strip with a double twist and the next two interconnected mobius strips one moving faster than the other – the universe and the anti universe. These in turn split as described producing an infinite hierarchy of interconnected mobius strips each of which contains all previous ones in the series of its advance. The second such split produces the physical and the energetic universe and their anti universe equivalents. This process of structure formation goes on in what we call evolution to produce the elements, then the galaxies, then the stars systems, then the planets, then the molecules, then single celled organisms, then multi-cellular entities, then trees and animals and so to us, societies, nations and now Gaia “and you ain’t seen nothing yet”.

This model produces a totally connected universe each component of which is an interconnection between a fast and a slow dynamic. This produces what we call form. This is a structure deriving “energy” from the universe. The fast dynamic produces positive feed forward(back) and the slow dynamic the negative feed forward (back) using

\(^4\) There is an interesting conundrum with respect to time as we normally conceive it in this model. As the universe and each of its infinity of distinct constituent parts all only have one surface edge and one edge any two adjacent points in this mobius field must be $2\pi$ units of length apart from each other. This produces a paradox that each is both later and earlier than its neighbor. In a very real sense therefore there can thus be no flow and no time in this sense. Ergo we do not even need process to have the universe. It can be constructed out of nothing – WOW – the initial statement of this paper. However time as we know it does it exist. We can distinguish between later and earlier entities in the hierarchy of structure processes so we can have astronomical and evolutionary time but time is an absolute sense does not exist at all and so time travel must be possible, double WOW.
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what we chose to call information to produce the shape of the form we see differentiated by a boundary at its edge. The linked fast and slow dynamic together form what could be described metaphorically as a local potential “mining” operation, an entity. This could be a galaxy, a solar system, an atom, a molecule, a single celled biological genus, a multi-cellular genus, humanity, human enterprises, societies of enterprises or a whole planet, seen as Lovelock has, as one totally interconnected integral organism, called Gaia by him in our instance of this process.

The basic unit in every part of this universe is therefore two interlinked mobius strips. The faster moving of these we generally label as energy. This produces positive feed forward. The other is a structure preserver using negative feed forward to sustain stability, homeostasis. This model works relatively well at the level of the atom\(^5\). It can also suffice to deal with astrophysical entities to a reasonable degree of short term accuracy. It immediately fails to be a sustainable perspective at the level of what we choose to call life.

Stafford Beer’s Viable Systems Model (VSM) suggests that you need two such systems to be interconnected to produce a viable continuing entity. The “lower” one, what he called systems 1 and 2, tactically generating the resources the entity needs from its environment. The higher more slowly operating one, what he called systems 4 and 5, scanning the environment and strategically planning and organising the entity’s capacity to respond to environmental change. What happened to Beer’s System 3? You might well ask.

The model as we have presented deals with the energy mining and structure forming processes that are required but note that the “lower” structure is also interlinked with the “higher” structure and it is at that interface we find Beer’s System 3.

Beer’s work deals with managerial cybernetics and the processes of information and control it exemplifies. These processes occur at the interfaces between the two systems not within them. He calls this process “transduction” and it can involve negative feed forward,” attenuation”, or positive feed forward “amplification”. System 3 provides the interface between the “strategy” determined by the higher level system and the “tactics” executed by the lower level systems in interfacing the entity with its environment. Level 3 thus runs the “operation” of the entity that locks its lower level function into the purpose fro it defined by its identity.

\(^5\) Please note this is not valid if one takes account of what goes on nowadays in high energy subatomic physics
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System 1s interfaces with the external environment to extract potential (energy) from it – note their can be many of these function within one entity (this is where James Grier Miller’s huge variety of $20^6$ not 19 functions come in)

System 2s interfaces with System 1s to regulate their responses to the environment in a manner consistent with the directed needs of the entity-

System 3 interfaces with the set of functions carried out by a number of systems 1 and 2 to monitor their performance and balance their access to supporting resources to ensure homeostasis and autopeosis occur.

System 4 scans the environment to interface with System 3 to ensure it is directing action in a manner leaving the entity viable

System 5 monitors the activities of System 4 to ensure these are consistent with the sustainable purposes of the entity, its distinct identity, and the long term viability of this.

Note that the identity, the distinct form of the entity, is maintained by the higher level slower processes (Systems 3 – 4) while the sustainment of the entity occurs at the lower levels in multiple functions (Systems 1 – 3).

A key feature of Beer’s credo and approach to the oneness we are dealing with is that as it generates a nested infinite hierarchy of structproceses to be effective in understanding them and their significance to us he to focus our minds on one, “the system in focus”, a Viable System. This consists of on one higher level interconnected pair of mobius fields, providing the entity’s identity, coupled with a supporting, possible multiplicity, of lower level one(s) (functions) – James Grier Miller reckons there are 20 of these in a “living system”.

In achieving such focus we have to also take account of the interface this entity has with its external environment. This is firstly all the systems below it the hierarchy into which it dips in its search for the energy it needs to survive and into which it excretes its waste. Secondly these are the systems above it in the hierarchy to which it must also stay connected and whose needs from it have to be eventually reconciled with its own needs. It is this higher level closure of the super system in which an entity is always embedded that is the focus of Howard Odum’s work and his concept of “emergy” that forces us to consider not just on autopeosis of the entities we belong to, societies, economies and nations but their sustainable coherence (viability) in relation to what we like to call the “natural” environment we have non-constructed, Lovelock’s “very old” new entity, “Gaia”.

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$^6$ He introduced a 20th after his book was published.
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Now this paper has not dealt with fractals. However this universe is fractal. The trigonometric functions we have used to parameterise it are defined over the whole complex field of numbers. The slow dynamic (feedback, negative feed forward, attenuation) provides a sequence of sub-entities parameterised on the real numbers and the fast entity (potentially explosive feed forward, positive feedback) an infinite variety in each of these parameterised over the imaginary numbers. We thus have a potentially infinite number of distinct genus, species/phenotypes and within these a similar infinity of potential forms, entities with a unique identity.

This model thus has embedded within it the Periodic Table which is defined over two dimension, atomic mass and electronic energetic intensity and a system of classification for biological if not all entities based on their position in the evolutionary tree and the initial specific singularity that caused their genus or species to come into being, emerge. We can quite comfortably consider a Super Periodic Table for these two systems of classification and if we take Odum’s work into account a Meta-Periodic Table based on mass (biomass) and emergy based on what Troncale would call allometry.
SYSTEMICS AND THE MUTUALLY BINDING ECONOMY NETWORKS;
A KNOWLEDGE BASED APPROACH FOR SUSTAINABLE
COMMUNITIES

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ABSTRACT

The monetary concentration due to global financial-economic system finally conducts
to increase the monetary inequity and unsustainable communities (Gini Index, OCDE).

Mutually Binding Economy Networks pretends to close the distance between producer and consumer; generally poor communities and rich people all over the world, by supplying social mechanisms usually for products distribution; solidarity, equity commerce, responsible consumption, loyal economy, etc. In the most of cases these communities works in an empirical level of the collective intelligence. The exchange results obtained by primitive communities were competitive with Nature, even with others communities in such primitive world. In front of today global economy, the communities constructed by old empirical models are going to be dead in a few years if they do not include the knowledge in their networking ways.

This article describes how in small communities, a knowledge based network improved by systemic methodologies and models, could allows best results in a short term for the community dynamics, favoring the emergence of a long term perspective in a sustainable development. In addition, some results in real cases in these communities and networks, in the northeast of Mexico are shown.

Key Words: Systemics; Mutually Binding Economy Networks; New Economies Communities; Knowledge Based Sustainable Communities.

I.- INTRODUCTION;
EQUITY COMMERCE, RESPONSIBLE CONSUMPTION AND LOYAL ECONOMY

Social web interaction from which new Mutually Binding Economy paths are taken, are placed at the bottom of a new long term and hopping human development.

Between these paths, Equity Commerce (EC) is one of the principal today activities carried on in several countries, particularly in stable or advanced economies countries, to turn (Laszlo, E., 2000) to this new searched world (Hayes, R., 2002).

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Also cofounders of Huakori Group, A.C., allied to Syntony Quest a Non Profit Organisation on USA.
The EC objective is to give a just payment to the people in rural, suburban or urban communities who produce, extract and distribute, transform raw materials or make final products. Social organisms like non-profit organisations, citizen groups, ecologist groups and environmentalists, do this altruist work, frequently without a demanded remuneration. Some countries like Canada have even a State Secretary dedicated to benevolent work, generally carried out by retired people with free time to offer to others who need it. There fore, people who have more can give some help to people who have less, nevertheless reaching the compensation is other than monetary.

Since more than a decade in Mexico the “Red Mexicana de los Pobres con Dignidad,A.C.” (Poor People with Dignity Mexican Network), is working like a non profit organisation supported by the Mexican Episcopal Conference, Caritas México, A.C., and a big number of other civil organisations, spread in more than 20 states of Mexico promoting, transporting, distributing and selling products from margined poor communities.

At the same time in the sustainability direction, this Network promotes the Responsible Consumption (RC), as an important component, complementary to the EC.

Self consumption is promoted in those communities as well, privileging seasonal, organics and non industrialised products.

These two elements help these communities to reach better quality life, promoting material health to people and simultaneously facilitating gods and services interchange. All this contribute to improve the Nature-Man relationship which means to be in “syntony”, as is conjointly promoted by Syntony Quest, in the USA and Huakori Group, in Mexico, organisations that work together in such a transformative processes.

II.- MUTUALLY BINDING ECONOMY COMMUNITIES AND SOCIAL ETHICS

The economy is an interaction social tissue permitting gods, services and knowledge interchange in a population (Capra, F., 1996).

This is well known by most of the economy schools. Nevertheless, consumption society based in the neoliberal system, supported by multinational structures, favour and impulse the flux, commerce and consumption (Rostow, W., 1963) of highly industrialised and pollutant products, privileging disposables. Since they focus on the growth of monetary and financial capital, mainly unscrupulous enterprises over explode and degrades natural resources zones, which are at the end of the so called “productive chains”.

In the opposite, mutually binding Economy Networks are growing in other countries including Mexico, promoting the flux of knowledge by mutual learning among the community members, and between them with the other communities´ people in order to create Evolutionary Learning Communities (ELC) (Castro-Laszlo, K., 2001).
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It would be interesting search to answer the Kathia Castro-Laszlo question; “How to create the conditions for an ELC and the emergences of a design culture?” (Castro-Laszlo, K, 2001), because it seems that the emergency of the evolutionary process is present now, at last in the Mexican Mutually Binding Economy Communities case in which the knowledge economy is present. Nevertheless we could not to say that it is under a design culture, because it was not conceived like that.

In the other hand, if the knowledge flux is made by an ethic and solidarity (mutual binding) path with the intervention of self-responsibility, it would favour the communities evolution based in its own creativity and its capacity to self-learning. It also promotes a major quality of life with dignity, based on social ethics, mutual respect, justice and solidarity, characteristics which are reinforced by a positive feedback under the knowledge interchange. Such a tendency is given by the evolutionary potentiality of the Human Kind.


In the material plane, where usual products and services interchange is carried on, communities like The Purepechas ethnic group in Michoacan, like others in Veracruz and Puebla in Mexico, have been reached an internal flux systematisation, without the use of currency.

Internally, as it was done in the Tianguis Purpecha, an itinerant market is established going around different states and cities of Mexico, promoting its products by no money means. To do that, the Purepecha people as a community, has created
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something in substitution of the current national money, which at the interior of its Mutually Binding Economy Tianguis. In this case, they use like as a metaphor “la Penca”, common Mexican name assigned to the flat stem-leaf of the Nopal plant, with a pallet form, to name the current circulation money used in the Mutually Binding interchange.

Here, like in others communities using interchange in a non lucrative way to search the Mutually Binding economy, people make it with the free criteria of “to pay” for a product or a service several times its thru market price, in opposition to what happens in the global market. That is done in a complete free and conscious action, in attention to the selling people needs, with the only purpose to help each other.

The common target is to circulate gods and services, inside the community, to reach common benefits for all of people, over the individual benefit. The common wellbeing of the community, in this kind of economies, is privileged over to the individual or familiar wellbeing, then, its stability goes increasingly. But more important than this, is the fact that is doing in syntony to their human potentialities and natural resources. The Tianguis Purpecha has reached its 14th anniversary in 2007, and recently they was in Parras de la Fuente, a municipality placed 90 min. driving to the Southwest of Saltillo, the capital city of Coahuila, in the Northeast of Mexico, where Huakori’s Group members had participated. (Photo-1.).

All this process approach to the Social Ethics (Teissier, H. 2005), is generally absent in the consumption economies which search and explodes the immediate satisfaction of the individual, the egoist commodity and the personal benefits, over the human dignity of its producers, who are exploited directly or indirectly by the buyer and the commercial intermediaries in the distribution chains and networks.

In the consumption economies where buy at the lower price is considered the “best buy”, there is a lack of consideration on detriment of the producers and their natural resources, done through the commercialisation. Since the buy is made in a “competitive” manner, as the fixed levels by the international commerce system; the World Trade Organisation, the OPEP, the OCDE or others organisms, it is well justified and prized.

At the limit, the consequences are overcharges in the natural ecosystems capacities, to the Nature services and products generator Systems (Teissier, H., 1998), also for the marginal communities in the Planet, most of them living in impoverished countries with unpaid external debts, who brings the maximum production volumes, generally beyond the natural and human systems restitution capabilities. This explains the non sustainability, the natural systems degradation, the expended and generalised poverty, the inhuman alimentary rates and the worst health conditions found in a great part of humanity, among other impacts derived form the global economy system.
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III.- KNOWLEDGE, COMMUNITY DEVELOPMENT AND SUSTAINABILITY

From the up-cited cases it is clear than the basis of a health community economic development, human and naturally, is not only the monetary circulation, nor the products or services interchanged, but the human-nature interactions network.

In the Mutually Binding economy, knowledge, comprehension and wisdom are interchanged in an empirical form, and this state of such community could perform a revolution in the human social system, a new social system all over the world.

Wile in the global economy system the material values are fostered, in the novel emergent economies (Bunnell, P., 2006) the Human Be is searching something more than obviously is not placed in a material dimension; data, quantification or information, levels cited by Russell Ackoff as the primitive ones, in the path of wisdom. Nevertheless, those empirical forms could be improved in none an imposed way, facilitating communities to transit to their own development. This form could be sustained in a non formal knowledge exchange, sheared and loyal, but definitively induced by dynamic levellers out of the system.

When we talk about a material and cognitive interchange network inside of a community, we talk in a systemic conception in a non explicit form. But more than that it would favouring the collective intelligence creation based on shearing knowledge.

Contrary to what is happening with the so called “knowledge societies”, whose bottom is foster their incubation to privilege the international economic, industrial and commercial growth of products circulation oriented to monetary objectives, the Mutually Binding economies reinforced by sheared knowledge, favors the development and not the growth (Ackoff, R., 1993), the stability and not the turbulences nor the environmental or ecologic disequilibrium, which improves to advance to a sustainable society.

A community with a Collective Intelligence, shares its knowledge when it have a clear value of its natural resources for its life and pass it to its descendents, appreciating those beyond their prices in the global market. A consumption based society fails to recognise, ignore or forget those non tangible values contained in the supporting life ecosystems, over the Planet.

In the deep, the sustainable development is stopped by heavy presence of the monetary-financial world system, who gives more to whom has more (Teissier, H., 2006-1), spreading individuals, fragmenting communities and its knowledge, conducting to a human degraded existence.
IV.- THE IMPORTANCE OF KNOWLEDGE IN THE DEVELOPMENT OF SUSTAINABLE COMMUNITIES

The sustainability could not be reached, not even approximated, if our communities don’t arrive to have a collective intelligence, to permit us to learn deeply the Nature Knowledge.

And the evidences show that the global economy considers such Nature Knowledge has no value as it is not susceptible to enter in the monetary scale, let say to be valued like an input for the industrial-financial process and products generation, demanded by a growing market impelled by the consumption.

But monetary value is not the only one, what explains, by example, the illness prevention like basic knowledge of the traditional medicine has been greatly delayed to input to the occidental medical world.

It would be recommendable a collective intelligence expansion, based on Man and Nature profound knowledge to create learning communities susceptible to approach a sustainable life.

All other mimetic present “green” forms, invented by the global economic system, are only chimera inside a sustainable development frame.

It is only by this than the profound knowledge W. Edwards Deming talks in his Total Quality Theory (Deming, W.E., 1989) is so difficult to be reached by the contemporary consumerist society.

V.- NEW POSSIBLE ATTRACTORS TOWARDS SUSTAINABILITY, THROUGH MUTULAY BINDING ECONOMY

The growing exploration of new Mutually Binding Economy schemes could generate complex attractors (Chaos Theory) converging on the gestation of sustainable communities.

Contrary as said by Brundtland Report, the consumption economy is not compatible with sustainable schema, since its powerful depredation capacity over the natural systems, as has been demonstrated in the last four UNEP GEO’s reports (GEO 1, 2, 3, and 4), also said by the 2008 last editions of the WorldWatch Institute, in which new economic sustainable options, accordingly the natural systems capacities.

In front of the great atmospheric alteration by anthropogenic causes, and derived on the Global Climate Change, accepted in 2007 by the Intergovernmental Panel for the Climate Change (IPCC, 2007), humanity affront today and by the next decades, tremendous changes in the climate structure of the hole Planet, carrying on consequence not only over the lost of a great part of the living species, but unpredictable human health and life processes affectation over the world.

At the turbulence present time, announced 15 years ago by system people like Russell Ackoff, James Lovelock and Frijof Capra, the Mutually Binding Economy is seen as a
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dissipative growing media in which the world can transit to sustainability, without facing the financial-economic global system, as attempted by the 60’s and 70’s ecologist movement on till present, but without successful.

The Mutually Binding Economy could form new complex attractors, permitting us to escape to the actual system, which had caught the most powerful country economies.

A test of this is the China inclusion to the global economy, a country opposed by centuries to the west culture where the neoliberalism has irrupted in an extreme form, causing severe alterations even to the United States command as well as rest of the Planet.

All this has done in detriment of its environment and the own China’s people, increasing the inequity with a growth of its consumerism economy, which is propagating over the world at a rhythm of about of 10% annual.

VI.- THE SYSTEMICS IN THE MUTUALLY BIDDING ECONOMY NETWORKS OF SUSTAINABLE COMMUNITIES

Nevertheless, the community transition to the Mutually Biding Economy for the sustainability is not easy and non trivial affair, neither. It is necessary to get certain systemic components to support this transition

Primarily, it is necessary to pass from events to behaviours and then search opportunities to evolve to dynamic structures. To pass form events to behaviours means to create social processes or to change the present ones. This is the most difficult part, since implies the change of old paradigms strongly rooted in our life ways. Some of them are:

1.- To pass from the communitarian tank conception to the flux view. It means for the community to abandon the old idea than the resources are there, stored like a divine gift to whom we have the right to access by the fact they are in our territory or domain. It must be transformed by a perception of the required inputs for the life holding come from processes with flux and these must be permanently maintained, avoiding its exhaustion, precisely to search the sustainability.

2.- It is essential also, to pass from the event emotion to the interaction continuity among the subsystems, processes and actors in the community. That is; the community must create an internal necessities and capacities network, where everybody knows which are their potentialities that can help the community with knowledge, facilities, experiences and talents, to be pivots of the communitarian evolution in that different kind of economy.

3.- It must be changed the casual empirics forms to the social tissue sustained in the natural capacities of the own community. It is necessary to avoid the creation of artificial states that could make fissures in both learning processes and evolution. By the opposite, it is important to conserve traditions and customs, lighting such
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particularities whom are distinctive from others communities, which may be the values to interchange in the future.

4.- Favours to pass from dependence to interdependence, and then to the search of social levering points that could motivate the community actors to rise its human quality of life (the Be), by replacing the having habits to a new vision based in the knowledge; to know Be, to know share and to know live, as components of a continuous learning process, to increase the profound knowledge for life.

These four points comes form Systemics and they provide an evolutionary complex process that could facilitate the Mutually Binding Economy Communities to transit to the sustainability.

A crucial point is that a Mutually Binding Economy could not be developed from outside of the communities that form the Network. It means what it can be done, in such a case, is to facilitate the communities to a self-design their own mutually binding economy processes, in frame of co-creation (Laszlo, A., 2001) to follow a self-learning path.

CONCLUSIONS

The Mutually Binding economy Communities and its Networks supported by the Collective Intelligence, the System Thinking and a cognitive conception could be converted, with a strong possibility, in the new humanity attractors. Certainly we have to improve in its design and construction, like Kathia Castro-Laszlo cites in her studies, since the present economic structure has eliminated the possibility that it could be done by emergence, spontaneity or hazard. If it is reached on time to gestate this kind of communities and its proliferation is made vigorously, Human Kind could have a survival hope. If not, we will see the consequences, first against the poorest and unprotected people, which means all over the majority of the countries in the Planet (Lovelock, J. 2007).

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APPLICATION OF A MODEL OF PLANNING FOR THE CONTINUOUS IMPROVEMENT OF THE DEVELOPMENT OF THE TELECOMMUNICATIONS

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ABSTRACT

The communications systems are used to send information from a place to another one through different means like the space, the optical fiber and metallic wiring. The most common systems among others, are the television, radio, infrared, satellite, the telephone ones, voice on IP that consist of sending the voice on an IP. The objective is continuously to improve the form to make get at the addressee the information generated by the source, of fast, safe way truthful and low cost.

This model consists of five stages: first is the Projection of Reference in which one detects problematic of the system using the techniques of Kawakita Jiro (TKJ), analytical hierarchal structuring and the principle of Pareto; in the normative planning the mission of the system considers that includes its goals and objectives; the strategic planning raises how to give solution to the detected problems; the organizational planning proposes the resources with which the problematic one will be solved; the fifth stage is the evaluation that allows to know what is feasible to do.

STRUCTURE OF THE MODEL OF PLANNING OF HAZAN OZBECKHAN

Problematic

The problematic one constitutes an aid to be able to see clearly which is the focal object, defined this one like the system in which it has been interested, that is to say, the part on which control can be exerted on the part of which they carry out the planning.

Within first stage one will be used the Kawakita-Jiro technique (TKJ), classifying the problematic one by groups, the model of decisions of Analytical Hierarchal structuring, the principle of Pareto and the applied technique of Ishikawa during this phase of the model.

Projection of Tendencies and Logical Future.

This part, jointly with the definition of the interest system and its problematic one, is what Projection of Reference is denominated. The phase of projection implies the prognosis through a series of historical statistical data, or of tendencies detected in qualitative form with base on a consultation of experts. Through this one, it is tried to know which would be the state or dimension of a problem in a specific future; this state is what it has been denominated future logical; he is the future more probable or natural.
A Model of Planning for Continuous Improvement

Figure 1. Model of Planning of Hazan Ozbeckhan.

1 Hazan Ozbeckhan, Thoughts on the Emerging Methodology of Planning, in systems and Management Science, Wiley, USA, 1974

Normative Planning

The essential task on this phase of the planning process consists of the precise definition of the aims that persecute the system.

Strategic Planning

Once the pertinent problematic has been determined, with the degree of necessary detail and the aims have been designed that are tried to reach in participative form, has one more a clearer idea of the effort that will be necessary to make to transform the system of the present state towards which it is desired. It is possible to begin now with an estimation of costs, hour-man, specific investments, reconstructions, etc. the form in which these resources will be used will have to be effective, efficient and coherent.

Organizational Planning

Once defined what to do and how to do, the planning model takes to the question on what resources must count so that the system becomes to the way wished with the design of strategies. This part closes the cycle of the global method of planning, the execution of combat operations will begin to transform the system of the predicted way if everything well were designed.
A Model of Planning for Continuous Improvement

Evaluation

The evaluation stage is related to the fact of establish the qualified system of information to the process, which can detect in the most frequent way the values of the variables more relevant with the object to receive on time deviations to the wished values and make the qualified corrections.

APPLICATION OF THE MODEL OF PLANNING OF HAZAN OZBECKHAN

In the case of telecommunications is pretended to apply this model that will allow the correct performance for the improvement of them, as well as the quality that allows the full satisfaction to their national and international users.

According with the model of planning of Hazan Ozbeckahn we are going to consider every stage of it.

KAWARITA-JIRO TECHNIQUE APPLICATION

Identifying the problematic

To realize this technique a questionnaire was elaborated and it was sent to the experts to detect the communications problematic, once obtained their answers with a total of 50 questionnaires 31 problems were obtained because there were similar answers. First was argued if they were well elaborated, this is, that they weren’t solutions, causes, etc. later the sentences where existed confusion or they weren’t well posed, were modified, to do that, the authors were asked to do the make the necessary explanations.

Once reclassified the problems there were the next results:

1. Politics of the telecommunications
2. Politics of the national telecommunications
3. Politics of the regional communications
4. Politics of the world communications
5. Telecommunications rules
6. National normatively
7. Regional normatively
8. World normatively
9. Information security
10. Virus attacks
11. Hackers participation
12. Efficient in the communications systems
13. A few development in the telecommunications industry
14. Difficult of adapting the enterprises about updating their technologies.
15. Services integrations.
16. Service lack
17. Products quality
18. higher prices
19. Low quality in some services
20. Incompatibility of services
21. Training
A Model of Planning for Continuous Improvement

22. Low personal self-respect
23. Deficiency training people
24. Deficiency in the knowledge of the people to engineering levels and in others areas
25. Enterprises without research department
26. Deficient infrastructure principally in rural zones and small cities
27. Areas
28. Equipment
29. Work tools
30. Coordination between internet producers in Mexico in order to offer a save net to the users.
31. Low impact in wide band and cable television services in the country

Later the similar problems were gathered together, getting 6 groups to the total problematic of the system identified by the Z letter, those 6 final problems because of the Yi, and in the thirty-one, problems because of the Xij letter.

Z. system total problematic

\[ Y_1 \text{Politics of telecommunications} \]
\[ X_{11} \text{National communications politics} \]
\[ X_{12} \text{regional communications politics} \]
\[ X_{13} \text{world communications politic} \]

\[ Y_2 \text{regulation of telecommunications} \]
\[ X_{21} \text{National normative ness} \]
\[ X_{22} \text{regional normative ness} \]
\[ X_{23} \text{world normative ness} \]

\[ Y_3 \text{security in the information} \]
\[ X_{31} \text{viruses’ attacks} \]
\[ X_{32} \text{hackers’ participation} \]
\[ X_{33} \text{efficiency in the communications systems} \]

\[ Y_4 \text{low growing in the telecommunications industry} \]
\[ X_{41} \text{difficulty of the enterprises adaptation in order to get renovated on the technologies} \]
\[ X_{42} \text{integration of services} \]
\[ X_{43} \text{scarcity of services} \]
\[ X_{44} \text{qualities on the products} \]
\[ X_{45} \text{elevated costs} \]
\[ X_{46} \text{low quality in some services} \]
\[ X_{47} \text{incompatibilities of services} \]
\[ X_{48} \text{coordination between the internet producers in Mexico to offer a save producers in net to the user} \]
\[ X_{49} \text{low impact of broadband and cable television services in the country} \]

\[ Y_5 \text{Training} \]
\[ X_{51} \text{Self-esteem in the workers} \]
\[ X_{52} \text{deficiencies in workers training} \]
\[ X_{53} \text{deficiency in the workers knowledge about engineering and other areas} \]
\[ X_{54} \text{enterprises without investigation} \]
A Model of Planning for Continuous Improvement

departments

Y₆ inadequate infrastructure in rural zones and small cities
X₆₁ areas
X₆₂ equipment
X₆₃ work material

Hierarchy of problems

Problems were evaluated by a computer program called “take in decisions and analytic hierarchy, where each one essential importance was taken in a comparison accordingly to the table of contents number I.

By means of this program the relative importance of the six problems were gotten, which we represent with the letter Y; the program calculates them in relation to the importance and intensity that each participant assigns to the different pairs of combinations (Y₁Y₂, Y₁Y₃, Y₁Y₄, Y₁Y₅, Y₁Y₆, Y₂Y₃, Y₂Y₄, Y₂Y₅, Y₂Y₆, Y₃Y₄, Y₃Y₅, Y₃Y₆, Y₄Y₅, Y₄Y₆, Y₅Y₆) and the one that decides must ponder the relative importance of the preferred element into the comparison in base to the scale of qualifications shown in table I. the thirty one problems of the inferior stratum are represented by an X and their percentages of relative importance are calculated by the program in the same way that the ones calculated by the Y. the addition of percentages of relative importance of each one of the Y problems gives the 100% of absolute importance of the Z problematic, in the same way, the addition of percentages X gives the 100% of relative importance of each Y. percentages gotten by the program are:

<table>
<thead>
<tr>
<th>Problematic</th>
<th>Relative Importance</th>
<th>Absolute Importance %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y₁ Politics of telecommunications</td>
<td>23</td>
<td>0.60<em>0.23</em>100=13.080</td>
</tr>
<tr>
<td>X₁₁ National communications politic</td>
<td>60</td>
<td>0.50<em>0.19</em>100=09.500</td>
</tr>
<tr>
<td>X₁₂ regional communications politic</td>
<td>25</td>
<td>0.35<em>0.19</em>100=06.650</td>
</tr>
<tr>
<td>X₁₃ World communications politic</td>
<td>15</td>
<td>0.25<em>0.19</em>100=04.750</td>
</tr>
<tr>
<td>Y₂ regulation of telecommunications</td>
<td>19</td>
<td>0.55<em>0.18</em>100=09.900</td>
</tr>
<tr>
<td>X₂₁ National normative ness</td>
<td>50</td>
<td>0.30<em>0.18</em>100=05.400</td>
</tr>
<tr>
<td>X₂₂ regional normative ness</td>
<td>35</td>
<td>0.15<em>0.18</em>100=02.700</td>
</tr>
<tr>
<td>X₂₃ World normative ness</td>
<td>25</td>
<td>0.15<em>0.17</em>100=02.550</td>
</tr>
<tr>
<td>Y₃ security in the information</td>
<td>18</td>
<td>0.55<em>0.18</em>100=09.900</td>
</tr>
<tr>
<td>X₃₁ Viruses attacks</td>
<td>55</td>
<td>0.55<em>0.18</em>100=09.900</td>
</tr>
<tr>
<td>X₃₂ Hackers participation</td>
<td>30</td>
<td>0.30<em>0.18</em>100=05.400</td>
</tr>
<tr>
<td>X₃₃ Efficiency in the communications systems</td>
<td>15</td>
<td>0.15<em>0.18</em>100=02.700</td>
</tr>
<tr>
<td>Y₄ low growing in the telecommunications industry</td>
<td>17</td>
<td>0.15<em>0.17</em>100=02.550</td>
</tr>
<tr>
<td>X₄₁ difficulty of the enterprises adaptation in order to get renovated</td>
<td>15</td>
<td>0.15<em>0.17</em>100=02.550</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Xij</th>
<th>Problem Description</th>
<th>Weight</th>
<th>Impact Calculation</th>
<th>Impact (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X42</td>
<td>integration of services</td>
<td>14</td>
<td>0.14<em>0.17</em>100</td>
<td>02.380</td>
</tr>
<tr>
<td>X43</td>
<td>scarcity of services</td>
<td>12</td>
<td>0.14<em>0.17</em>100</td>
<td>02.040</td>
</tr>
<tr>
<td>X44</td>
<td>quality on the products</td>
<td>11</td>
<td>0.11<em>0.17</em>100</td>
<td>01.870</td>
</tr>
<tr>
<td>X45</td>
<td>elevated costs</td>
<td>11</td>
<td>0.11<em>0.17</em>100</td>
<td>01.870</td>
</tr>
<tr>
<td>X46</td>
<td>low quality in some services</td>
<td>10</td>
<td>0.10<em>0.17</em>100</td>
<td>01.700</td>
</tr>
<tr>
<td>X47</td>
<td>incompatibility of services</td>
<td>10</td>
<td>0.10<em>0.17</em>100</td>
<td>01.700</td>
</tr>
<tr>
<td>X48</td>
<td>coordination between the internet producers in Mexico to offer a safe net to the user</td>
<td>9</td>
<td>0.09<em>0.17</em>100</td>
<td>01.530</td>
</tr>
<tr>
<td>X49</td>
<td>low impact of broadband and cable television services in the country</td>
<td>8</td>
<td>0.08<em>0.17</em>100</td>
<td>01.360</td>
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</table>

Y5 Training

<table>
<thead>
<tr>
<th>Xij</th>
<th>Problem Description</th>
<th>Weight</th>
<th>Impact Calculation</th>
<th>Impact (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X51</td>
<td>Self-esteem in the workers</td>
<td>40</td>
<td>0.40<em>0.14</em>100</td>
<td>05.600</td>
</tr>
<tr>
<td>X52</td>
<td>deficiency in workers training</td>
<td>30</td>
<td>0.30<em>0.14</em>100</td>
<td>04.200</td>
</tr>
<tr>
<td>X53</td>
<td>deficiency in the workers knowledge about engineering and other areas</td>
<td>20</td>
<td>0.20<em>0.14</em>100</td>
<td>02.800</td>
</tr>
<tr>
<td>X54</td>
<td>enterprises without investigation departments</td>
<td>10</td>
<td>0.10<em>0.14</em>100</td>
<td>01.400</td>
</tr>
</tbody>
</table>

Y6 Inadequate infrastructure in rural zones and small cities

<table>
<thead>
<tr>
<th>Xij</th>
<th>Problem Description</th>
<th>Weight</th>
<th>Impact Calculation</th>
<th>Impact (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X61</td>
<td>areas</td>
<td>55</td>
<td>0.55<em>0.09</em>100</td>
<td>04.950</td>
</tr>
<tr>
<td>X62</td>
<td>equipment</td>
<td>25</td>
<td>0.25<em>0.09</em>100</td>
<td>02.250</td>
</tr>
<tr>
<td>X63</td>
<td>work material</td>
<td>20</td>
<td>0.20<em>0.09</em>100</td>
<td>01.800</td>
</tr>
</tbody>
</table>

The figure number 2 shows the hierarchical arboreal structure that is divided in three levels:

![Arboreal Hierarchical Structure of the Problematic](image)

The first level consist in the total problematic of telecommunications (Z), the second level is conformed by the six problems, assorted by the (Y1), within we find the thirty one problems represented by (Xij), the graphic ends in the third level due to each one of the elements cannot be divided already into other problems to consider.
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PARETO’S PRINCIPLE

The Pareto’s principle (principle 20-80) establishes that if we consider the 20% of the most important problems, and we add the absolute importance of each one of them, we get approximately the 80% of the absolute importance from the total problematic. This means, that we could solve the 20% of the principal problems for not to waste our efforts and resources in the others, due to the low impact in the total problematic.

Table II.- Absolute importance and amount of Pareto from high to low importance

<table>
<thead>
<tr>
<th>Problems in significance order</th>
<th>Element</th>
<th>absolute importance</th>
<th>Paretó amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>politic of national communications</td>
<td>X11</td>
<td>0.1308</td>
<td>0.1308</td>
</tr>
<tr>
<td>viruses attacks</td>
<td>X31</td>
<td>0.0990</td>
<td>0.2298</td>
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<tr>
<td>national normative ness</td>
<td>X21</td>
<td>0.0950</td>
<td>0.3248</td>
</tr>
<tr>
<td>reional normative ness</td>
<td>X22</td>
<td>0.0665</td>
<td>0.3918</td>
</tr>
<tr>
<td>politic of regional communications</td>
<td>X12</td>
<td>0.0575</td>
<td>0.4488</td>
</tr>
<tr>
<td>low self-esteem in the workers</td>
<td>X51</td>
<td>0.0560</td>
<td>0.5048</td>
</tr>
<tr>
<td>hackers participation</td>
<td>X32</td>
<td>0.0540</td>
<td>0.5588</td>
</tr>
<tr>
<td>areas</td>
<td>X61</td>
<td>0.0495</td>
<td>0.6083</td>
</tr>
<tr>
<td>world normative ness</td>
<td>X23</td>
<td>0.0475</td>
<td>0.6558</td>
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<tr>
<td>deficiency in the training of workers</td>
<td>X52</td>
<td>0.0420</td>
<td>0.6978</td>
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<td>politic of the world communications</td>
<td>X13</td>
<td>0.0345</td>
<td>0.7258</td>
</tr>
<tr>
<td>deficiency in the workers knowledge about</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>engineering and other areas</td>
<td>X53</td>
<td>0.0280</td>
<td>0.7538</td>
</tr>
<tr>
<td>efficiency in the communications systems</td>
<td>X33</td>
<td>0.0270</td>
<td>0.7808</td>
</tr>
<tr>
<td>difficulty of adaptation to renovate the technologies</td>
<td>X41</td>
<td>0.0255</td>
<td>0.8063</td>
</tr>
<tr>
<td>services integration</td>
<td>X42</td>
<td>0.0238</td>
<td>0.8301</td>
</tr>
<tr>
<td>equipment</td>
<td>X62</td>
<td>0.0225</td>
<td>0.8526</td>
</tr>
<tr>
<td>scarcity of services</td>
<td>X43</td>
<td>0.0204</td>
<td>0.873</td>
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<tr>
<td>quality in the products</td>
<td>X44</td>
<td>0.0187</td>
<td>0.8917</td>
</tr>
<tr>
<td>elevated costs</td>
<td>X45</td>
<td>0.0187</td>
<td>0.9104</td>
</tr>
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<td>material of work</td>
<td>X63</td>
<td>0.0180</td>
<td>0.9284</td>
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<td>low quality in some services</td>
<td>X46</td>
<td>0.0170</td>
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<td>incompatibility of services</td>
<td>X47</td>
<td>0.0170</td>
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<td>coordination between the internet producers in Mexico to offer a safe net to the user</td>
<td>X48</td>
<td>0.0153</td>
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<td>enterprises without investigation departments</td>
<td>X54</td>
<td>0.0140</td>
<td>0.9917</td>
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<tr>
<td>low impact of broadband and cable television services in the country</td>
<td>X49</td>
<td>0.0081</td>
<td>0.9998</td>
</tr>
</tbody>
</table>
ISHIKAWA TECHNIQUE

This technique also known as fish skeleton was used to detect the reasons of the problems, for that, the questionnaires of the experts were reviewed and with the help of the TKJ technique were detected the causes of the considered problems. Then, an abstract was made, getting seven general causes and their specific causes per problem.

Relation of Problems with their Specific Causes

Politic of nationals communications

- Information given to population about the development of telecommunications
- Population training for the use of the telecommunications

![Graph showing the relation of problems and their specific causes](image)

Figure 3.- Problems Ordered from Greater to Shorter whose Absolutes Importance Amount Gives the Pareto’s Amount.

- There exists a lack of communication in some communities in the country
- Protectionism of the national companies

Viruses attacks
- Carelessness from the programmers
- Lack of vaccinations
- Lack of care from the users

National normative ness
- Frauds
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- Inadequate publicity
- Affectation to audio & video enterprises
- Tightfisted development of telecommunications

**Regional normative ness**
- Incompatibility in the services
- Inadequate publicity
- Affectation to audio & video enterprises
- Tightfisted development of telecommunications

**Politics of regional communications**
- Information to population about the development of telecommunications
- Population training for the use of telecommunications
- Exists lack of communication in Latin America countries
- Protectionism of the national companies

**Low self-esteem in the workers**
- Lack of incentives in the work
- Low personal interactivity in the work
- Information of the objectives and goals of the enterprise

**Hackers’ participation**
- Make use of the programming mistakes
- Piracy of programs
- Inadequate programming

And so, in the same way we can find the general and specific causes of each considered problem.

Next, we present an example of the Ishikawa schemes with their general causes.

![Ishikawa diagram]

**Bibliography**


A Model of Planning for Continuous Improvement


SYSTEMS OF THINGS THAT FLOW

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ABSTRACT

Diagrammatical descriptions are used extensively in understanding systems. Typically, systems are expressed in terms of heterogeneous symbols that represent basic characteristics of the system, including elements, connections, flows, communication, etc. This paper introduces a new model to describe flow-based systems. It models “things that flow,” such as information, materials, actions, and money. They are distinguished by flowing in five states: received, processed, created, released, and communicated. The new model is applied to typical systems to contrast them with classical descriptions.

Keywords: flow model, system modeling, conceptual modeling

INTRODUCTION

Systems approach is a valuable methodology for understanding organizations and solving problems. Diagrams are widely used tools for describing systems. Prior to quantifying processes of a complex systems problem, the configuration of the system components and their interconnections must be visualized.

The “flows” inside the system are important factors in the intertwining of its connected components. This paper concentrates on a specific type of system: a system of “things that flow.” “Things that flow” include information, materials (e.g., in manufacturing), money, etc. The notion of flow is a widely used concept in many fields of study. In economics, the goods circular flow model is well known; in management science there is the supply chain flow. In computer science, the classical model of flow is the 1949 Shannon-Weaver communication model, representing electrical signal transfer from sender to receiver. It reflects the concept of “flow” in terms of three stages: information being transmitted, information in the channel, and information being received. Flow of information means the movement from one information sphere (the sender) to another information sphere.

Typically, systems are described in terms of heterogeneous symbols that represent basic characteristics of the system, including elements, flows, communication, etc. These descriptions mix types of flows. The resultant diagram is a rough sketch of related ideas, not appropriate to be called a system because the mere word "system" gives the impression of reasonably clear components and relationships.

Alternatively, we use a flow model (FM) that separates different types of flow with the possibility that one flow “triggers” another flow. The flow indicates movement of a single
Systems of Things that Flow

type of thing inside and between spheres. The sphere is the environment of the flow and includes five stages with possible sub-spheres (e.g., storage). The stages may be named differently according to the things that flow. For example, in an information sphere, a stage may be called *communication*, while in raw material flow the same stage is called *transportation*.

The main purpose of this paper is to raise interest in FM in the area of systems sciences. We will first review FM as described by Al-Fedaghi (2008a, 2008b, 2008c), with some new illustrations of its characteristics. Formalization of some of FM features will also be described. Next a classical description of a reservoir with feedback will be given to illustrate the advantages of FM modeling.

**RELATED WORKS**

Graphical representation is commonly utilized to communicate a system’s functional and data flow characteristics and requirements. The Function Flow Block Diagram (Blanchard and Fabrycky 1990), Data Flow Diagrams (DeMarco 1979), Use Case, Sequence Diagram, and Behavior Diagram are examples of such representation. General informal graphical diagrams are also used in systems sciences. It is this last type of diagram that is targeted in this paper. One objective of developing a new flow model is that it be used to enhance these types of graphical representations of systems.

The notion of flow has appeared in numerous works in systems science. However, it seems that it has not been used as the fundamental characteristic of system the way FM has. The clearest emphasis on flow is expressed by Simon and Clair (1998) as follows:

[F]or an electric-power generation and distribution system, the systems engineer will show in diagrammatic form how the energy flows as it is converted from the basic fuels to steam in boilers, then into steam turbines; or from waterfalls to water turbines to electric generators; then through transformers, through switching systems, transmission lines, and out to the various users where, again, it is altered in form many times. This would be an energy flow chart, and it would serve as a backbone around which additional systems considerations will be studied. To accompany this an information flow chart would be created because none of the switching systems, motors, generators, and people, acting over what might be a very great geographical span, would know what to do unless they are directed to do so by a control network that moves the information about, stores that information where required, processes it, interprets it, etc.

**FLOW MODEL**

The flow model (FM) was first introduced by Al-Fedaghi (2006) and has been used since then in several applications, including engineering requirement analysis (Al-Fedaghi, 2008a, b, and c).
In FM, the flow of “things” indicates movement inside and between spheres. The sphere is the environment of the flow and includes five stages that may be sub-spheres with their own five-stages schema. The stages may be named differently. For example, in an information sphere, a stage may be called communication, while in raw material flow the same stage is called transportation. The information creation stage may be called manufacturing in the materials flow. We will move between these terms as the spheres change.

In reviewing FM, we will assume that the “thing that flows” is information. An information sphere denotes the information environment (e.g., company, department, or person). The lifecycle of information is a sequence of states as it moves among stages of its lifecycle as follows:

1. Information is received (i.e., passengers arriving at an airport).
2. Information is processed (i.e., subjected to some type of process, e.g., compressed).
3. Information is disclosed/released (i.e., it is designated as released information, ready to move outside the current sphere, like passengers ready to depart from airports).
4. Information is transferred to another sphere (e.g., from a customer’s sphere to a retailer’s sphere).
5. Information is created (i.e., generated as a new piece of information using data mining).
6. Information is used (i.e., it is utilized in some action, analogous to police rushing to a criminal’s hideout after receiving an informant’s tip). Using information indicates exiting the information flow for another type of flow such as action. We call this point a gateway in the flow.
7. Information is stored. Thus, it remains in a stable state without change until it is brought back to the stream of flow.
8. Information is destroyed.

The first five states of information form the main stages of the stream of flow, as illustrated in Figure 1.
When information is stored, it is in a sub-state because it occurs at different stages: information being created (stored created information), processed (stored processed information), and received (stored received/row information). The five-stage scheme can be applied to humans and organizations. It is reusable because a copy of it is assigned to each agent.

The five information states are the only possible “existence” patterns in the stream of information. To follow the information as it moves along different paths, we can start at any point in the stream. Suppose that information enters the processing stage, where it is subjected to some process. The following are ultimate possibilities:

1. It is stored.
2. It is destroyed.
3. It is disclosed and transferred to another sphere.
4. It is processed in such a way that it generates implied information (e.g., \(a\) is the father of \(b\) and \(b\) is the father of \(c\) generates the information that \(a\) is the grandfather of \(c\)).
5. It is processed in such a way that it generates new information (e.g., comparing certain statistics generates the information that \(Smith\) is a risk).
6. It is used to generate some action (e.g., upon decoding or processing the information, the FBI sends its agents to arrest the spy who wrote the encoded message). In the uses sub-stage, information is not a patient. The patient is a term that refers to the thing that receives the action.

The storage and uses/actions (called gateways) sub-stages can be found in any of the five stages. However, in the release/disclosure and communication stages, information is not
usually subject to these sub-stages, so we apply these sub-stages only to the receiving, processing, and creation stages without loss of generality. Figure 2 shows the interiors of these stages.

The “storage” in each stage represents information in a static state. Thus, as information is received, it may be stored in its received condition for a later time when it is activated by being returned to the flow stream. Implicit in Figure 2 is the fact that information may be destroyed and/or duplicated through copying.

Figure 2 is a detailed version of Figure 1, showing how the receiving stage leads to the processing stage, which in turn leads to the creation stage. The creation stage may lead back to the processing stage. These three stages may lead directly to the disclosure/release stage, then the transmission stage, which in turn leads to the receiving stage of another sphere.

To illustrate the “gateway” sub-stage, imagine that a person in Barcelona (sender) uses the Internet to ask a person (recipient) in New York whether it is raining in New York. Figure 3 illustrates the information flow. First, the query flows through narrow arrows to the receiving stage of the New Yorker. It triggers (dotted arrow = gateway) the New Yorker to some type of action (e.g., opening the widow to check whether it is raining). Triggering indicates a change in the “thing that flows” from information to actions. Actions also can be received, processed, created, released, and transported. The action of the New Yorker triggers (dotted arrow = gateway) the creation of a response (information) that flows back (bold arrows) to Barcelona. The receiving and disclosure
stages in the systems have been duplicated in order to simplify the figure. We ignore here the fact that mental information is ontologically different from digital information.

Figure 3. Flow of information through gateway that triggers an action.

FORMALIZATION OF FM

According to De Rosnay (1979),

The most widely used definition of a system is that it is "a set of interacting elements that form an integrated whole." A city, a cell, and a body, then, are systems. And so are an automobile, a computer, and a washing machine! Such a definition can be too general. Yet no definition of the word system can be entirely satisfying; it is the conception of system that is fertile—if one measures its extent and its limits.”

De Rosnay (1979) goes further to provide the most complete definition:

A system is a set of elements in dynamic interaction, organized for a goal. There is nothing mysterious about the "goal" of the cell. It suggests no scheme; it declares itself a posteriori: to maintain its structure and replicate itself. The same applies to the ecosystem. Its purpose is to maintain its equilibrium and permit the development of life.

In FM a system is the five stages schema and may include sub-stages as described previously. Next we concentrate on developing such a definition of a system.

What is a System?

FM is a model of things that flow. To use a neutral term, we will use the term flowthing to denote a thing that flows, hence, is received, processed, created, released, and communicated. In FM, a system denotes a dynamic movement (flow) of flowthings inside and outside the system. The system structure is defined in terms of the five stages schema.
Systems of Things that Flow

as described previously. Let us designate the stages as follows. REC is the receiving stage, PRO is the processing stage, CRE is the creation stage, REL is the releasing stage, and COM is the communication stage. An FM system, S, is defined as follows:

(1) S is a flowthing system such that $S \mid \{\text{REC, PRO, CRE, REL, COM, [S]}\} | S$

[S] denotes series of sub-systems (e.g., company has several departments),

and flow among stages is defined as:

REC $\rightarrow$ PRO, REC $\rightarrow$ REL, PRO $\rightarrow$ CRE, PRO $\rightarrow$ REL, CRE $\rightarrow$ PRO, CRE $\rightarrow$ REL, REL $\rightarrow$ COM.

where arrow $\rightarrow$ denotes flow of flowthings.

$\mid$ and $|$ denote a production process where several FM systems (with sub-systems produced in [S]) form one global system.

(2) Let $f$ be the flowthing in S1 and $g$ be the flowthing of S2, then:

- If $f$ is ontologically similar to $g$ then COM $\rightarrow$ COM in the schemata of S1 and S2 is permitted. That is, if the flowthing is of the same type (e.g., information) then the flow between two systems goes through the communication stages of these systems.

- If $f$ is ontologically not similar to $g$, then only XXX $\rightarrow$ YYY in the schemata of S1 and S2 is permitted, where $\rightarrow$ denotes the triggering of flow in another system, and XXX and YYY are stages. That is, any stage in S1 can trigger any stage in S2.

The elements of S (five stages system) are characterized by being exchangeable (received and communicated), creatable, processible, and releasable. Exchangeability means that elements can be imported and exported to other systems. Creatability means that new element can be generated by the system. Procesesibility means that elements are changeable to different forms. Releasability means that elements can be designated as exported outside the system.

In addition to the fundamental characteristics of flow in FM, the following types of possible operations exist in different stages:

1. Copying: Copy is an operation such that flowthing $f \Rightarrow f$. That is, it is possible to copy $f$ to produce another flowthing $f$ in a system S. In this case, S is said to be S with copied features, or, for short, Copy S. For example, any informational schema can be copy S, while physical schemata are non-copying S. Notice that in copy S, stored f may have its copy in a non-stored state. It is possible that copying is allowed in certain stages and not allowed in others.

2. Erasure: Erasure is an operation such that flowthing $f \Rightarrow \emptyset$, where $\emptyset$ denotes the empty flowthing. That is, it is possible to erase a flowthing in S. In this case, S is said to
be S with erasure feature, or, for short, erasure \( S \). Erasure can be used for a single instance, all instances in a stage, or all instances in \( S \).

3. Canceling: Anti-flowthing \( f^- \) is a flowthing such that \((f^- \cup f) \Rightarrow \emptyset\), where \( \emptyset \) denotes the empty flowthing, and \( \cup \) denotes the presence of \( f^- \) and \( f \) simultaneously. It is possible that the anti-flowthing \( f^- \) is declared in a stage, a schema, or a sphere. If the flowthing \( f \) triggers the flow of the flowthing \( g \), then the anti-flowthing \( f^- \) triggers the anti-flowthing \( g^- \).

An example of the utilization of these FM features is erasing a flow, as in the case of a customer who orders a product then cancels the order. This may require the cancellation of several flows in different schemata that were triggered by the original order. Copying is an important feature for some types of flowthings such as information. For example, a received order may be stored in the received stage while its copy is passed on to the processing stage. Such a feature may be important in declaring constraints, as in the case of personal information privacy. Similarly, destroying information may be an operation that needs strict control.

**Open and closed systems**

In classical thermodynamics, an open system exchanges energy, matter, and information with its environment (ecosystem). A closed system exchanges neither matter nor information with its environment. An isolated system is a physical system that does not interact with its environment.

Figure 4 shows a diagram of a closed system in FM. The flowthing is assumed to be a stage-less system. Usually we do not show the flowthing node when we draw a system, only when it is necessary. Notice that, by definition, a system is a system of things that flow; hence, the flowthing is an integral part of the system.

![Figure 4. An isolated system in FM.](image)

Figure 5 shows a diagram of an open system. It includes at least two sub-systems where either of them can be the environment. To emphasize the environment, one of the systems can be inside the other.
Consequently, a closed system in thermodynamics can be represented as a closed system of material and information flows, and an open system as an energy flow system, as illustrated in Figure 6.

Figure 6. Closed system is “defined” in FM as an open energy flow system, and isolated material and information flow systems.
RE-VISITING SYSTEMS

Typically, systems are described using heterogeneous symbols that represent basic characteristics of any system, including elements, flows, valves, communication, etc. Figure 7 shows such a description of a system with feedback and flows (De Rosnay, 1979).

The description mixes three types of flows: flow of liquid, flow of information, and implicit flow of action. The flow of action is understood from the box labeled "Decision" and the valve. This means that according to a decision, an action is taken to open or close the valve. Conceptually, this mix of flows is disturbing. Imagine a network with water and electricity coming and/or going from the same (node) source and destination. In Figure 4, the Reservoir is the source of flow of water to the Sink, and simultaneously, the source of information flow to Assembled Information. The information seems to flow directly into the flow of water at the valve. Additionally, it seems that there is a "gap" between the destination of the water at Decision and the valve. The valve represents an action that results from Decision and is directed to the flow of water. The conceptual structure even depends on the special proximity of Decision to the valve to indicate their relationship. The resultant diagram is a rough sketch of related ideas, not appropriate to be called a system, where the mere word "system" gives the impression of reasonably clear components and relationships.

In contrast, in FM, things are precisely modeled. Figure 8 shows three separate flows: water, information, and actions. The liquid enters the liquid flow system at circle 1 through the transporting stage. It flows to the receiving stage (circle 2) and to the reservoir (circle 3).

The access liquid flows back from the reservoir to the release stage (circles 4 and 5), to be transported outside the system (circles 6 and 7). The receiving stage, where the reservoir resides, triggers (circle 8) the creation of information about the liquid level in the informational sphere. This information may be processed (circle 9); accordingly, a decision (information) is made (created) that triggers an action (circle 10). The action
(valve control) triggers (circle 11) a module at the transport stage that stops the flow of liquid (refuses to accept more) from outside. Figure 9 shows a version of the FM description. For the sake of simplification, the transporting stage is duplicated in the liquid flow system.

Figure 8. FM description of the system in Figure 4.

Figure 9. Simplified FM description of the system in Figure

Comparing Figure 6 with the classical diagram in Figure 4, the FM description shows the three flows systematically as separate streams that affect each other. It could also be enhanced by adding additional stages and spheres. The outside could be a system that is represented in a similar way. The information sphere can include a receiving stage that represents human control intervention.
Systems of Things that Flow

MULTI-SPHERE MODELING

According to Smith (2000),

A System is a set of connected things. A single item is not a system, but when separate things interact together they form a system. Understanding each thing separately is necessary but not sufficient to understand the behaviour of a system. Traditional analyses used a 'Reductionist' approach in that they reduced a complex system to its separate components as a means of understanding. A 'Systemic' approach is 'holistic' in that it seeks to understand the system as a whole.

Smith applies the “systemic” approach to describe “A car as system.” A car comprises a few thousand components. Figure 10(a) is a partial view of a system map of a motor car (Smith, 2000). Cars are driven by people. This system could be called “A person driving a car,” and is sometimes called a “socio-technical system.” Figure 10(b) is a partial view of a system map of this system (Smith, 2000). The purpose here is not to give a complete account of these descriptions; rather, the objective is to show a diagrammatical description in order to contrast it to FM modeling.

![Diagram of a car system](a)

![Diagram of a person driving a car system](b)

Figure 10. Partial views of systemic descriptions of Motor car and “a person driving a car” given by Smith (2000).

We will show an FM description of some flows in the motor car and its environment system to illustrate the capabilities that can be achieved using such a model. Because of space limitation, we limit our modeling to some flows in the motor car, driver, and gas station systems. Figure 11 identifies these selected modeled systems and their sub-systems.
1. The motor car: We selected three parts of the motor car to model: the engine, the gas pedal, and the gas supply system. The model parts of the engine include two sub-systems: engine physical action, and engine fuel system. The modeled parts of the fuel supply include fuel storage and the fuel gauge system.

2. The driver: The modeled systems of the driver include his/her informational sphere, action sphere, and needs and desires sphere.

3. The gas station: the gas station model is limited to supplying gas.

Figure 12 shows the resultant model of these systems and sub-systems. It has two main columns: the motor car subsystems on the right, and the driver’s sub-systems on the left, in addition to the gas station system at the bottom of the left-hand column (black box).
Figure 12. FM description of some flows among motor car, driver, and gas station.
Gas flows from the gas station to the fuel storage of the car (circle 1). It is received in the fuel storage, where it is stored in the car’s tank (circle 2). Fuel flows from the tank to the engine (circle 3), where it reaches the engine fuel system (circle 4), is received, and is then fed to the physical engine action (circle 5).

Going back to the fuel tank in the car’s fuel supply system, the fuel level in the tank triggers (circle 6) the fuel gauge to generate information about the fuel level. This information is communicated to the driver in his/her informational sphere (circle 7). Now we are in the driver’s domain. The driver utilizes the information about the fuel level to take some action (circle 9). We stop at this point of flow and turn our attention to the creation of needs at the top left corner of the figure. Of course we can continue modeling from point 9, for example, the driver processes the information about the fuel level and initiates an action to drive to the nearest gas station, etc.

At the top left side of the figure, in the driver’s needs sphere, needs are created (circle 10), hence, they generate an action (circle 11). Notice that triggering does not go through the communication stage because needs do not flow to actions. Rather, needs trigger (dotted arrow) an action. We assume that such actions are concerned with controlling the gas pedal of the car (e.g., increasing or decreasing speed).

The generated action flows to the pedal system (circle 12), which receives it and communicates the action to the engine physical action system (circle 13). In the engine system, the action is “processed,” causing change in speed (circle 14).

This conceptual description is a map of different modeled parts connected by different flows of information, fuel, and actions. It can be used for design, educational, and exploratory studies. Notice the uniform application of the five-stages schema for different systems and flows.

**ECOSYSTEMS**

An ecosystem has been defined as a dynamic system composed of a biotic and abiotic community and its associated abiotic environment. It is a term that originated from biology. Pidwirny (2006) describe ecosystems as follows.

Ecosystems are composed of a variety of living organisms that can be classified as producers, consumers, or decomposers. Producers or autotrophs are organisms that can manufacture the organic compounds they use as sources of energy and nutrients. Most producers are green plants that can manufacture their food through the process of photosynthesis. Consumers or heterotrophs get their energy and nutrients by feeding directly or indirectly on producers. We can distinguish two main types of consumers. Herbivores are consumers that eat plants for their energy and nutrients. Organisms that feed on herbivores are called carnivores. Carnivores can also consume other carnivores. Plants and animals supply organic matter to the soil system through
shed tissues and death. Consumer organisms that feed on this organic matter, or detritus, are known as detritivores or decomposers. The organic matter that is consumed by the detritivores is eventually converted back into inorganic nutrients in the soil. These nutrients can then be used by plants for the production of organic compounds.

Pidwirny (2006) introduces a graphical model, shown in figure 13, to describe the major ecosystem components and their interrelationships.

![Diagram of ecological system](image)

**Figure 13.** Relationships within an ecosystem as described by Pidwirny (2006).

This description may be used as an initial description of the ecosystem; however, it is conceptually disturbing since the arrows represent many types of flows. For example, it may be accepted that the arrow from the sun to the plants represents flow of energy. However, it is difficult to imagine the thing that flows from Plants to Decomposition. It can include materials such as bodies; then how do bodies flow to the atmosphere? The semantics of the arrow between Decomposition and Atmosphere may indicate “production,” that is, decomposed bodies generate gases and water. But this semantics is different from the semantics of the arrow from SUN to Plants, which represents a flow of energy. The best way is to take the arrows in the figure as indicators of relationships among components.

Figure 14 shows a partial view of the corresponding FM description. Certain systems and flows are omitted because of the width of the drawing page. The figure includes the following systems.

1. Sun: with creation, release, and transporting stages of energy.
Systems of Things that Flow

Figure 14. Partial view of FM description of the ecosystem.
Systems of Things that Flow

2. Plants: The system of Plants has four sub-spheres (systems):

- Energy flow system
- Atmospheric gases flow
- Food (material) flow
- Nutrients & water

3. Consumption
4. Detritivores
5. Atmosphere

Consider starting with the creation of energy in the sun that flows to the energy system of plants (circle 1). Energy is used in internal processing (circle 2) to create materials that flow to consumers (circle 3). The processing of food inside the consumers lead to waste products and, ultimately, their own dead bodies, which end up feeding detritivores (point 4) that that produce Nutrients & water (circle 5) and atmospheric gases (circle 7). Dead plants also feed detritivores (circles 9 and 13).

For simplicity’s sake we have not included separate sub-systems for Nutrients & water and gases in the detritivores’ system. Nutrients & water are used as food in the food system of the plants (circle 6).

At circle 7, gases are received in the atmosphere. Atmospheric gases flow to the gas system of the plants (circle 8) to be used in manufacturing food (circle 10).

We start now at the “creation” of gases (O₂ or CO₂) in plants (circle 11) where gases flow to the atmosphere (circle 12). The flow of gases between the atmosphere and consumers can be modeled in a similar way; however, we have omitted this flow from the diagram (circle 14).

This FM description is a road map for the whole ecosystem landscape. The repeated application of the five stages schema gives the model a uniformity that is rarely found in modeling complex systems.

CONCLUSION

The flow model separates different types of flow with the possibility that one flow “triggers” another flow. The resultant FM description is suitable for modeling flow-based systems as demonstrated by examples. While FM is still under development, it is clear that it introduces new aspects to conceptual description of systems in the field of systems sciences.

Further research needs to investigate modeling of other types of systems in FM. The exact place of FM among different diagrammatical descriptions also needs to be explored. One point is clear: FM modeling can enhance many of these descriptions. Also, FM seems to reveal a more fundamental structure in systems of things that flow.
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WHAT'S THE NORTH-KOREAN NUCLEAR WEAPONS' FUTURE?
- COMPLEX-SYSTEMS APPROACH -

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ABSTRACT
Two years before, North-Korean Government sentenced they have been had Nuclear Weapons. In correctly, October 9th, 2006, North Korean Government announced they had tested the Nuclear Weapons at the northern part of their territory. Also, they insisted their testing was successful with in triumph. They sentenced their country will be stronger than any other countries. It’s means that they will have the hegemony of the Korean Peninsula.

By the way, South Korea, U.S. and Japan also China didn’t want to accept the North Korean Nuclear Weapons. They worry about the break up with North-Eastern countries’ weapon balance. Also, for South Korean people didn’t want the existence of Nuclear Weapons in Korean Peninsula. They thought the Nuclear Weapons will not be a good environmental condition to unify the divided two Korea.

Anyway, the effort to remove the North Korean Nuclear Weapons is most important subject for Asia-Pacific countries. Therefore, they set up Six Party Talks to solve the North Korean Nuclear Weapons. Also, they made the promise to solve the North Korean Nuclear Weapons. On Feb.13, 2007 North Korea and Six Party Talks members agreed to shut down and disable its nuclear programs and weapons in return for incentives provided by other members of Six Party Talks-United States, Russia, China, Japan and South Korea. But, up the present North Korean Government didn’t make a satisfactory response. I wonder if how the North Korean Nuclear Weapons be destined to future. I’d like to research ‘What’s the North Korean Nuclear Weapons’ Future?’ by Complex Systems Approach.

Keywords: complex systems, satisfactory response, nuclear weapons, weapon balance.

1. INTRODUCTION
Nowadays, the North Korean Nuclear Weapons is a big interesting issue for every country. It’s because the North Korean Nuclear Weapons is a serious issue for Six-party countries. North Korean Authorities announced they have no doubts about their policy or action with their Nuclear Weapons. But, Six-party countries worry about the proliferation of Nuclear Weapons from North Korea to Syria. Also, someone worry about the proliferation of Nuclear Weapons from North Korea to so called terrorist groups.

On April 8, 2008, South Korea and the United States have agreed to focus on “monitoring” North Korea's potential uranium enrichment activities and nuclear proliferation with Syria, instead of “verifying” suspicions. The two sides agreed that
plutonium-based programs, which pose substantial threats, should be verified immediately and completely. It’s actualized ‘Singapore Meeting’ by U.S and North Korean chief nuclear negotiators. The deal was aimed at resolving differences over the North Korea’s nuclear declaration, which was promised by the end of last year under the so called Feb. 13 nuclear pack signed by the two Koreas, U.S. China, Japan and Russia.

Also, U.S. and Six-party countries will close observation the suspected uranium enrichment program (UEP) and nuclear proliferation to Syria, however, a focal point would be a strengthening and monitoring system to prevent North Korea from engaging in such activities.

By the way, Washington would start the process of removing North Korea from its list of terrorism-sponsoring states in exchange for the North's full denuclearization. (By Jung Sung-ki, Staff Reporter of Korea Times, Apr.16, 2008). Any way, North Korean Nuclear Weapons Problem is a hot issue for us. Also, how it could be solved is a critical issue for South Korean people.

Of course, it will be a complicated quiz for us. Giving up the Nuclear Weapons for North Korean Government is not easy for their generic character. But, I think it's possible to explain by the Social Entropy Theory.

I’ll quote Prigogine’s theory and Yaneer Bar-Yam’s explanation about the complex systems and Bailey’s Social Entropy Theory.

In this paper, I’d like to research ‘What’s the North Korean Nuclear Weapons’ Future?’ by Complex Systems Approach.

### 2. COMPLEX-SYSTEMS APPROACH

#### 2-1. Complex-systems Approach methodology

In general, studying complex systems approaches are two methods. The first method is a specific system is selected and each of the parts as well as their interactions are identified and described. The second method considers a class of systems, where the essential characteristics of the class described, and statistical analysis is used to obtain properties and behaviors of the systems. (Yaneer Bar-Yam. 1997). In this paper, I selected the first method to make a complex systems approach to research the North Korean Nuclear Weapons’ future.

Yaneer Bar-Yam’s explanation about the complex systems in a unified framework has become recognized in recent years as a new scientific discipline, the ultimate of interdisciplinary fields. (Yaneer Bar-Yam, 1997)

I think we need considering the complex systems property for explaining the change of system. The properties of complex systems are change, growth, and death, possibly from life cycle. For complexity to emerge, two ingredients are necessary. The first essential ingredient is an irreversible medium in which things can happen: this medium is time, flowing from the past that lies closed behind us toward a future that is open. The second essential ingredient is nonlinearity. (Hyuk Kihl, Kwon’s paper. 2007, 51st ISSS Annual Conference)
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We are all familiar with linear systems that have been the mainstay of science for a long time. But, the nonlinear systems do not obey the simple rules of addition. Nonlinearity causes small changes on one level of organization to produce large effects at the same or different levels. In general, nonlinearity produces complex and frequently unexpected results. Irreversibility and nonlinearity characterize phenomena in every field of science (Peter Coveny & Roger Highfield, 1995). The two properties are the main ingredients of complex systems.

By the way, Social Entropy is a measure of the natural decay within a social system. It can refer to the decomposition of social structure or of the disappearance of social distinctions. (Bailey, 1995)

Modern Western complex societies remain organized by large inputs of energy to mitigate the natural progression of increasing entropy (disorder), according to the Second Law of Thermodynamics, a fundamental law of physics. This effectively states that entropy (disorder) increases with time. As the system becomes more complex, through access to energy, it becomes more susceptible to changes that may occur if one were to remove this source of energy.

Also, I’d like to quote the Prigogine’s an entropy equation.

\[ dS = deS + diS \]

dS means total of the entropy in the system and deS means the entropy from the outside. On the other hand, diS means the entropy from inside because of irreversible processes. (Bailey, 1995)

It’ll be a more useful explanation tools for my topics.

2-2. Complex-systems Approach to explain the North Korean Nuclear Weapons’ future.

David Easton's political system theory is full of suggestions for political analysis. And, it suggests that we could analyze North Korean political system’s reaction about the North Korean Nuclear Weapons. In Easton's assumption, a political system that is self-regulation can respond and can adapt itself to environmental changes. Meanwhile, thermodynamics is that part of physical science that is concerned with the conditions that material systems may assume and the changes in conditions that may occur either spontaneously or as a result of interactive between systems, including interactions such as heat, which cannot be described in terms of mechanics. More recently thermodynamics has been extended to include physical system in non-equilibrium states. This theory of thermodynamics, as Prigogine and Jantsch explicitly or implicitly suggested, can be properly applied to the study of social phenomena. In non-equilibrium thermodynamics there are the reciprocity relations. Reciprocity relations have been the most important dynamics in the thermodynamics of irreversible process (Yong-pil, Rhee.1999). I think to explain the North Korean Nuclear Weapons’ future is possible by complex systems approach.

At the present time, North Korean Nuclear Weapons didn’t remove from North Korea. Also, the negotiation is going with U.S. and North Korean negotiator. It’s actualized ‘Singapore Meeting’ by U.S. and North Korean chief nuclear negotiators. The deal was aimed at resolving differences over the North Korea’s nuclear declaration, which was
promised by the end of last year under the so called Feb. 13 nuclear pack signed by the two Koreas, U.S. China, Japan and Russia. By the way, Washington would start the process of removing North Korea from its list of terrorism-sponsoring states in exchange for the North's full denuclearization. (By Jung Sung-ki, Staff Reporter of Korea Times, Apr.16, 2008). I think such a process is one of the states of complex system's pertinent. Several systems are inter-connected each other. Also, each system affects the other systems.

Of course, it will be a complicated quiz for us. Giving up the Nuclear Weapons for North Korean Government is not easy for their generic character. But, I think it's possible to explain by Social Entropy Theory.

3. THE HISTORY OF THE NUCLEAR WEAPONS ON THE KOREAN PENINSULAR

3-1. Withdraw the NPT, and Break the Geneva Agreement

In September 1990, prime minister-level meetings between North Korean and South Korean officials took place in Seoul. The talks resulted in two major agreements: the Agreement on Reconciliation, Nonaggression, Exchanges, and Cooperation (the "basic agreement") and the Declaration on the Denuclearization of the Korean Peninsula (the "Joint Declaration"). The Joint Declaration called for a bilateral nuclear inspection regime to verify the denuclearization of the peninsula. The Declaration, which came into force on 19, February.1992, states that the two sides "shall not test, manufacture, produce, receive, possess, store, deploy use nuclear weapons," and that they "shall not possess nuclear reprocessing and uranium enrichment facilities." (Hyuk Kihl, Kwon, ISSS 2007 Annual Conference) This safeguards agreement allowed IAEA inspections to begin in June 1992. This promising development was halted by the North's refusal in January 1993 to allow special inspections of two unreported facilities suspected of holding nuclear waste. Ignoring the South-North Joint Declaration of the Denuclearization of the Korean Peninsula, North Korea refused IAEA inspections and operated nuclear reprocessing facilities, making the world suspicious of its nuclear intentions. The North's threat to withdraw from the Nuclear Non-Proliferation Treaty (NPT) brought North-South progress to an abrupt halt. Tensions ran high on the Korean Peninsula as the confrontation between North Korea and the United States.

Meanwhile, official negotiations between the two sides opened on July 8, 1994 in Geneva, and led to the signing of the Agreed Framework on October 21. The Agreed Framework signed by the United States and North Korea. North Korea would freeze its existing nuclear program and agree to enhance International Atomic Energy Agency (IAEA) safeguards. The objective of the agreement was the freezing and replacement of North Korea's indigenous nuclear power plant program with more nuclear proliferation resistant light water reactor power plants, and the step-by-step normalization of relations between the U.S. and the DPRK.

Both sides would cooperate to replace the North Korea's graphite-moderated reactors for related facilities with light-water (LWR) power plants. Under terms of the agreement, North Korea was obligated to freeze its graphite-moderated reactor at Yongbyon and halt construction of two more reactors. In return, the United States agreed to undertake to make arrangements for the provision to North Korea of a light water reactor (LWR) project with a total generating capacity of approximately 2,000
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MW(e) by a target date of 2003. An international consortium would be organized under the leadership of the U.S. to finance and supply the project. As a result, South Korean regime will burden 75% of the financial support. Light Water Reactor(LWR) do not hold the same potential as graphite-moderated reactors for the production of plutonium that can be reprocessed for use in the development of nuclear weapons. As an interim measure, while the light water reactors were under construction the United States was obligated to supply North Korea annually with 500,000 tons of heavy fuel oil for heating and electricity production.

Also, KEDO(Korean Peninsular Energy Development Organization) was going to make a LWR at the North Korean Shinpo area by South Korean Electronic Company. LWR model was unique Korean model devised by Korean Electronic Company. Actually, constructing LWR was big event for South Korean regime. South Korean regime would be a big sponsor of the LWR. (Hyuk Kihl, Kwon, ISSS 2007 Annual Conference)


3-2. North Korean Nuclear Explosion Test

Two years before, Oct 9th, 2006. North Korean Nuclear Explosion Test was terrible memory to South Korean people. North Korean Kim Jong-II tested the Nuclear Weapons. At that time, South Korean felt the fear and anger to North Korean Kim Jong-II regime. It’s because that South Korean didn’t want to exist Nuclear Weapons in Korean Peninsular. Also, U.S. Japan and China didn’t want to accept to have Nuclear Weapons of North Korea.

They should not reprocess the used fuel to produce the plutonium. I think North Korean Authorities have been had the fear of U.S. Also, they thought the nuclear weapon was the last shield for their lives. But, their selection was not so good. Especially, South Korean was frustrated by North Korean regime’s acts. The tension of Korean Peninsular is so high that world countries watch intently the North Korean regime.

President Bush said "The United States of America will not permit the world's most dangerous regimes to threaten us with the world's most destructive weapons."

Perhaps, Kim Jong-II may believe that a successful nuclear test provides him with a safety blanket from under which he may lash out at the region and cause greater instability. Actually, the possibility of a devastating North Korean attack on South Korea and Japan with the conventional rockets and missiles or from the useful weapons of mass destruction like Nuclear Weapons are terrible scenario for us.

4. COMPLEX SYSTEMS APPROACH THE NORTH KOREAN NUCLEAR WEAPONS’ FUTURE

In Easton's assumption, a political system that is self-regulation can respond and can adapt itself to environmental changes. Also, we can imagine the North Korean Nuclear
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Weapons’ future is a complicated situation as a complex system. Therefore, we can imagine various irreversible conditions to change North Korean Nuclear Weapons’ future.

4-1 ‘Singapore Meeting’ by U.S. and North Korean chief nuclear negotiators

On April.8, 2008, South Korea and the United States have agreed to focus on “monitoring” North Korea's potential uranium enrichment activities and nuclear proliferation with Syria, instead of “verifying” suspicions. The two sides agreed that plutonium-based programs, which pose substantial threats, should be verified immediately and completely. It’s actualized ‘Singapore Meeting’ by U.S and North Korean chief nuclear negotiators. (By Jung Sung-ki, Staff Reporter of Korea Times, Apr.16, 2008) Also, U.S and Six-party countries will close observation the suspected uranium enrichment program (UEP) and nuclear proliferation to Syria, however, a focal point would be a strengthening and monitoring system to prevent North Korea from engaging in such activities.

By the way, Washington would start the process of removing North Korea from its list of terrorism-sponsoring states in exchange for the North's full denuclearization. Anyway, North Korean Nuclear Weapons Problem is a hot issue for us.

The key issue in the Singapore deal is to what extent North Korea will report its nuclear assistance to Syria and alleged uranium enrichment program, neither of which it is willing to admit point blank. Under the compromise plan, the U.S. would make a report on these two issues "on North Korea's behalf" and North Korea would "acknowledge" U.S. concerns about the issues. (englishnews@chosun.com)

The declaration list will be the last part of the second phase of the denuclearization steps endorsed at the six-party talks. In Washington, the State Department underscored once again that verifying the North's production of plutonium will be a key part of the denuclearization process. Yongbyon facilities are currently being disabled as part of the second phase. The first phase was shutting down of the facilities. The next phase will involve verifying the past activities and dismantling them. (Lee Joo-hee ; Wednesday, April 23, 2008. Korea Herald, angiely@heraldm.com)

I think North Korean Leader Kim Jong-Il have to make a trust sincerely with six party talk countries. Not only making good promises, but also doing sincerely. And, recovery of NPT will be more trust from Six Party talk countries.

4-2 Invisible Pressure of the recovery of the relation with South Korean New Government

February, 25 inauguration of conservative Lee Myung-bak as South Korea's president will do much to repair the damage wrought by five years of the progressive Roh Moo-Hyun administration. Under Roh, Seoul's relations with the U.S. and Japan deteriorated, its outreach to North Korea was counterproductive, and domestic and foreign investors were driven overseas by vacillating economic policies and South Korea's declining competitiveness.

Lee Myung-bak is expected to improve strained relations with Washington, implement a more pragmatic policy toward North Korea, and establish a business-friendly environment. President Roh's departure also sets the stage for greater integration with the U.S. on security policy and more effective multilateral efforts to denuclearize North Korea. The result should be a firm foundation for realizing the full potential of the bilat-
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eral relationship. But, the result was not to be seen for Korean people. Passing about 10 years, South Korean Government was to be seen like a progressive regime. Also, South and North relation was to be seen smoothly. Of course, pull and push policy was lasted all around. Kim Dae-Jung and Rho Moo-Hyun government tried to ‘Sunshine Policy’ to North Korea. Its’ main stream is to pouring of material assistance to North Korea because of humanity. Also, South Korean government tried to make package tours to Mt. Kumgang and the Kaesong Industrial Complex. But, South Korean thoroughly betrayed by North Korean Kim Jong-il regime. It’s because they attack back part of South Korea. They made the Nuclear Weapons instead of the peace.

President-elected Lee will enjoy a honeymoon period of positive U.S. opinion, especially during an early summit meeting with President George W. Bush. However, to maintain U.S. support, Lee will have to avoid political landmines. He must describe his North Korean policy more fully, continue a vigorous outreach to the foreign business community, and deliver on his economic promises.

Lee Myung-bak’s pragmatic demand for conditionality in Seoul's engagement with North Korea will increase allied leverage in the six-party talks and reduce Pyongyang's ability to play the U.S. and South Korea against each other. A realistic policy that requires reciprocity and transparency from North Korea will also be more consistent with the six-party talks' goal of using coordinated multilateral diplomatic efforts to leverage Pyongyang's implementation of its nuclear commitments. (‘New South Korean President Brings Conservative Policy Change’ by Bruce Klingner, April 01, 2008)

Under President Roh, South Korea pursued a unilateral, uncoordinated policy that undermined the multilateral and conditional approach of the six-party talks. By providing billions of dollars in unconditional aid and promises of yet more largesse, Seoul minimized its influence over Pyongyang and marginalized its effectiveness in the talks. With a guaranteed pipeline of benefits from South Korea, North Korean leader Kim Jong-il had less need to comply with the "action for action" requirements of the talks.

Lee will maintain South Korea's engagement policy but will condition economic, humanitarian, and political benefits on the pace of North Korean denuclearization. This is a significant departure from Roh's approach of unconditional, asymmetric provision of benefits without demanding any reciprocal economic or diplomatic concessions from North Korea. (Bruce Klingner, April 01, 2008)

Therefore, North Korean regime criticizes Lee Myung-bak Government will be a compliant regime. Also, they tested launch-missiles near the northern Yellow Sea area. Sometimes they agitate South Korean leaders. North Korea test-fired a barrage of short-range missiles on March 28, the communist nation's latest apparent angry response to the new South Korean government's tougher stance on Pyongyang. (The Seoul Times, Tuesday, April 22, 2008)

Anyway, North Korean Kim Jong-II regime didn’t like new president, because of different from Kim Dae-Jung and Roh Moo-Hyun past president. In these days, South and North dialogue is stopped. Nobody knows when is the real time with the South and North confrontation is resolved. In fact, North Korean food shortage is serious all the country. They need more fertilizer and foods urgently. It’s means that Social Entropy increased so high. I think the best policy for North Korean Crisis is giving up their Nuclear Weapons and their rigid confrontation policy. In fact, recovery of the South and North Korean relationships is one of the best select for North Korean people. The first
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step is giving up their Nuclear Weapons permanently. The second step is making good relation with South Korea. Also, opening their country is the best way reducing social entropy.

4-3 Reducing Social Entropy by fulfilling Peoples’ demand

North Korea’s internal demands will work to increase the social entropy. In this year, food shortage is reported seriously. Past 1990s, millions of North Korean people died of food shortages. I think the North Korean Authorities will know about the Nuclear weapon will be a barrier to reach South and North Korean relationships. For a long time, North Korean people had been lived without sufficient materials. They were accustomed to endure the difficulty from hunger and difficult. I think all of North Korean want to be a plenty lives without hunger and difficult. They are exhausted with through the hard living life for a long time. Also, divided people will want to be a free travel with no threat at all. It means that North Korean regime have to abandon the Nuclear Weapons. But, there were bad news about the disappeared officials because of to try to start the incentive system. Hwang Jang-Yeup, 10 years before escaped from North Korea, said North Korea would be disappeared without South Korean regime’s support like ‘Sun-shine policy’. (Hyuk Kihl, Kwon’s paper. 2007, 51st ISSS Annual Conference) Anyway, I think internal demand of North Korea people will be one of the factors to remove the North Korean Nuclear Weapons.

Lee Myung-bak, South Korean New president announced if North Korean Authorities give up the Nuclear Weapons, and open the society will help North Korean brothers with heartily. His new policy is North gives up its nuclear programs and opens their society the South will help the North so that their per capita income will rise to $3,000 within a decade. This is the basis for the framework of Lee’s so-called Vision 3000, which aims to achieve a nuclear-free North Korea.

I think if North Korean Leader Kim Jong-Il admits the South Korean President’s suggestion, North Korean social entropy will reduce. Also, North Korean people's hard living will improve.

4-4 Time and Nonlinearity as special pertinent

I think ‘What’s the North Korean Nuclear Weapons’ future’ is more complex-systems problems. Actually, several systems are related each other. So many systems and factors inter-related each other. Also, time and nonlinearity is the property of the complex systems. We can imagine the North Korean Nuclear Weapons situation is one of the complex systems.

Also, ‘Time and Nonlinearity’ will be affected as special pertinent. ‘Time’ is will be a big pertinent for the North Korean Nuclear Weapons system. Actually, the North Korean leader will be changed as like human history. Also, the North Korean Nuclear Weapons system will be changed more rational situation. Also, Nonlinearity means that the future is unpredictable and flexible society.

Past 10 years, North Korean Authorities learned about South Korean Society is more abundant than North Korea. As a result, the North Korean Nuclear Weapons system will be change carefully. At last, North Korean regime will select to give up the Nuclear Weapons step-by-step. ‘Singapore Meeting’ by U.S and North Korean chief nuclear negotiators is the progressive example step-by-step. I think we need a time for the one
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step forwards. Of course, North Korean Leader Kim Jong-Il is not accustomed to South Korean New Government. But, time is the key which open the dialogue with two Korea.

It’s because North turns theirs face away from South is means losing big chance for their future. Also, their losing chance means their society will meet the more increased entropy in their country. Disorder and discontent will make the disturbance their society.

5. CONCLUSION

I think to Remove the North Korean Nuclear Weapon is one of the most difficult problems. But, it was inevitable problem for us Korean. All of the East Asian countries and U.S. concerned with North Korean Nuclear Weapons. I think ‘to remove the North Korean nuclear weapons’ is more complex-systems problems. So many systems and factors inter-related each other. Also, all of the factors are affected each other. Actually, several systems are related each other.

At chapter 4, I introduced several systems to explain for the removal of the North Korean Nuclear program. In a word, ‘to remove the North Korean Nuclear Weapons’ is not a single problem. As we noticed, we need to think about two pertinent. One is time, and the other is nonlinearity.

We can imagine the North Korean Nuclear Weapons situation is one of the complex systems. Also, we can imagine it have several factors like as the rising of South Korean Lee Myung-bak new president’s reciprocal directions. And, the sanctions and international pressure by the six-party talks, the pressure of recovery of the relation with South and North Korea, the North Korea’s internal needs for upgraded lives. Also, the social entropy will increase because of internal and external factors.

I think the best choice is to give up the Nuclear Weapons and appear to as an international real member.

We can conclude as bellows.

- North Korea will come back NPT and will be inspected thoroughly by IAEA as like other countries.
- Dialogue with South and North will open in the near future.
- ‘Singapore Meeting’ by U.S and North Korean chief nuclear negotiators will make a good conclusion.
- The pressure by six party talks will make a conclusion like a ‘Singapore Meeting’.
- The best choice to reducing social entropy is opening North Korean Society and making good relation with South and North Korea.
- In a word, North Korean Nuclear Weapons will dismantle step-by-step.
- North Korean Nuclear Weapons to be given up because of the survival of North Korean Political Systems itself.
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INCORPORATING SYSTEMS THINKING IN ORGANIZATIONAL CHANGE PROJECTS USING ACTION RESEARCH BY PRACTITIONERS CONDUCTING ACADEMIC RESEARCH

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ABSTRACT
This paper explores the use of systems thinking in action research projects. It will describe two ‘real’ action research projects, where soft systems methodology was used by managers who introduced change in their own organizations. It elaborates how applying this methodology supported the application of action research. Both managers who used action research have successfully completed their doctorates in programs conducted by an Australian university. The paper discusses the relationship between soft systems methodology and action research, examines the problems faced in using this methodology in action research and discusses how systems thinking could be effectively applied by management researchers planning to conduct academic research.

Keywords: Systems Thinking, Action Research, Soft Systems Methodology, Organizational Change, Management Research.

INTRODUCTION
This paper starts with a brief explanation of action research (AR) and soft systems methodology (SSM) and then describes a doctoral program conducted by an Australian university where AR is often used by practitioners conducting academic research. Two AR projects are then described in which SSM was used. Next, a discussion on the use of systems thinking in action research projects is presented. The paper concludes with some suggestions on how to embed systems thinking approaches in action research projects carried out by practitioners who are taking part in research projects in an academic environment.

ACTION RESEARCH
Although several varieties and versions of action research (AR) exist (Brooks and Watkins 1994, Raelin 1999, Reason and Bradbury 2001), the action research process described in this section is the one frequently adopted by practitioners conducting academic research in the university where the research projects described in this paper were carried out.
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According to Dick (2001), you pursue both action (change) and research (understanding) while conducting AR. AR incorporates critical reflection on the action to gain better understanding that results in more informed action. AR is also usually participative and qualitative although quantitative methods have been used by some of the researchers when the situation demanded it.

![Figure 1 General model of action research](image)

Often AR is carried out in a cyclical or spiral fashion. The most common form used by researchers in the programs used the Deakin cycle (Kemmis and McTaggart 1988) of plan-act-observe and reflect and then the cycle repeats itself. So often we start with a ‘fuzzy’ problem and as you take action, observe and reflect on the situation you converge through iterative cycles to a better understanding of the situation. This leads to better actions.

What methods can you use to conduct research? It is often said that in AR data drives the research. As an action researcher you should show some scepticism about what you found in order to disconfirm the findings. The more you try to disconfirm the findings the more rigorous the research will be. Therefore, it is quite common to find a mixture of methods being used in AR that offer different perspectives of the research problem at hand. The use of different methods also serves to triangulate the findings by helping to confirm/disconfirm the findings.

Typical methods used by the researchers in the programs were:

- Interviewing
- Large group intervention processes such as search conferences, open space meetings.
- Focus groups.
- Surveys.
- Project evaluation exercises.
- Soft systems methodology.
- Journal writing.
- Story telling and narrative analysis.
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SOFT SYSTEMS METHODOLOGY

SSM was developed through the work of researchers and practitioners from Lancaster University in the 70’s who found that the methods developed through the ‘hard’ systems approaches were inadequate to address ill-structured, complex, real-world problems faced by managers. While initially it was thought that ‘hard’ systems thinking was good to address well defined problems such as those that arose in ‘systems engineering’ and the ‘soft’ systems approach was for fuzzy problems Checkland (1999: A10) clarifies that the difference came from how systemicity is attributed to a system. Checkland (1995: 10) clarifies that ‘SSM has shifted the concept of systemicity from assuming that it can be the process of inquiry into the world to take action’. Thus hard’ refers to the world containing systems while ‘soft’ refers to systematically organized learning about the world.

New users of this methodology often use Checkland’s (1999: 163) seven-step model proposed in 1975 which involves considering the problem situation in both the ‘real’ world and the ‘systems thinking’ world where system language could be used to develop models.

Essentially, the seven steps are:

1. The problem situation ‘unstructured’
2. The problem situation ‘expressed’
3. ‘Root definition’ of relevant systems
4. Build ‘conceptual models’
5. Compare the ‘conceptual models’ with the ‘real’ world.
6. Think about feasible, desirable changes
7. Take action to improve the problem situation.

Stages 3 and 4 were in located in the ‘systems thinking’ world and - line separated the two worlds. As SSM started being used limitations were found and a ‘two strands (streams) model’ (Jackson 2003: 189) developed. One stream called the logical stream followed the path of the original seven-step model but a new stream called the stream of cultural analysis was introduced in the 80’s that includes three types of analysis – analysis about the intervention, social systems analysis and political systems analysis. Social analysis considered norms and values while political analysis provided information on power issues.

According to Checkland and Scholes (1999: 251-252) the seven step model of SSM grew out of a group of University staff helping organizations outside the university to address ill-structured problems. Therefore a consultancy framework using the seven-step model was required to intervene into problems occurring in the real world. As SSM started being applied to day–to-day work by practitioners like Scholes it became a mental model to think about problematical situation. The thinking or sense-making mode of SSM came to be called Mode 2 SSM while the stage-by-stage application of SSM is now known as Mode 1 SSM.

In a recent book by Checkland and Poulter (2006: 11) a basic version of SSM is presented using the following activities:

- A problematical real-world situation demanding action to improve it.
- Creation of models of purposeful activity relevant to the situation describing it expressing different worldviews
- A process to explore the models as devices to explore the situation
- A structured debate about desirable and feasible changes including a discussion on power issues and considering social norms and values
- Taking action to improve the situation.
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Even though a simplified version of SSM is shown in the latest book the process of analysis includes the various components described in the earlier more complex versions.

Figure 2 shows a basic simplified process of SSM (Checkland and Poulter 2006: 12).

The Dialectical Model of SSM

The doctoral researchers at the Australian university often used a dialectical version of SSM model based on Dick (2000).

Dick (2000) has considered SSM as progressing through four dialectics.

- **1st dialectic** – Between immersion (rich picture) and essence (root definition) where researchers try and experience the problem situation as fully as possible and then stand back and define its essential features.
- **2nd dialectic** – Between the essence (root definitions) and the ideals (conceptual model) where researchers try to find an ideal way to achieve the same transformation of inputs into outputs.
- **3rd dialectic** – Between ideals and reality where researchers think about improvement to the ideals or the actual situation.
- **4th dialectic** – Between plans and implementation where the plans are implemented and differences between plans and reality can be monitored through which further improvements can be carried out.
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Dick’s proposed way of using soft systems thinking using the seven steps of SSM is more ‘action’ driven than ‘concept’ driven and seems to have been easier to adopt while putting soft systems thinking into practice by the researchers.

THE DOCTORAL PROGRAM
The two research projects selected for discussion in this paper were from two different doctoral programs conducted by the university. The first project was carried out by a PhD candidate from Singapore (Sankaran et al. 2006). The second project is from a Doctor of Business Administration (DBA) Program conducted mainly from Australia but the researcher was from New Zealand where the university had a partnership with a local Institute of Technology. AR was one of several methodologies students used for their DBA theses. The two projects were selected as they incorporated SSM in different ways into AR.

A DIAGNOSTIC EXPERT SYSTEMS FOR AN INDUSTRIAL ENVIRONMENT
This project was carried out by the Technical Director of a Research and Development firm in Singapore for a PhD program (Tay 2003). The project involved the development of a diagnostic expert system for military vehicles that changed the way in which the software development firm designed and implemented software solutions.

Thematic Concern
The primary intention of this study was to solve logic faults that were occurring when the modelling software was being developed. The three primary questions that were asked to address the thematic concern of the research were:

• How to derive an (effective) inquiry process (to carry out the modelling)?
• How to refine the modelling techniques used?
• How to detect missing content?

Choosing Action Research
AR was selected as the research methodology as the researcher wanted to pursue action outcomes and research outcomes at the same time to address a problem that was a real concern to his firm. The project required active participation of designers and modellers developing the system, making AR useful. Due to its responsive nature AR also helped due to the generation of situation-specific knowledge. AR helped keep the project on schedule as project work and research work could be carried out simultaneously. The researcher used AR as a meta-methodology to embed other methodologies that helped in the investigation. SSM was one such methodology used.

Figure 3 shows the dialectic nature of AR moving between ‘thought’ and ‘action’ while going through the AR cycle of planning, acting, observing and reflecting.
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Figure 3 Dialectic nature of AR used in the research (Tay 2003: 87)

Incorporating Soft Systems Methodology

SSM was used in this research as an initial approach to understand the problem situation based on reading the works of Wilson (1984), Checkland and Scholes (1990), Dick and Swepson (1994), Mirijamdotter (1998), Checkland (1999), Dick (2000) and Curtis and Cobham (2002). Initially, the seven-step model proposed by Checkland (1993: 163) was used to set up the investigation. Setbacks were encountered and an inquiry process using Dick’s version of Checkland’s SSM was designed to fit the investigation (Dick and Swepson 1994; Dick 1993, 2000). This dialectic form of investigation is not a new form of Checkland’s SSM. It uses the same seven stages but it is presented from a different perspective. A trial was carried out using the four-stage Diagnostic Expert Modelling (DES) inquiry process. This process was then applied to several vehicles for which the diagnostic systems were required. Figure 4 shows how the inquiry process developed through two AR cycles.
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Cycle Activity
AR 1 Understanding the problem situation
AR 1.1 Applying Checkland’s SSM
AR 1.2 Analysing setbacks in using Checkland’s SSM
AR 2 Constructing DES models
AR 2.1 Deriving four-stage DES inquiry process using Dick’s version of Checkland’s SSM
AR 2.2 Adopting Reliability-Centred Management as the content guideline
AR 2.3 Using Jung’s psychological types as decision-making preferences
AR 2.4 Trialling the four-stage DES inquiry process
AR 2.5 Refining the diagnostic models for a new vehicle after using the model for three more vehicles

Figure 4 The first two action research cycles (Tay 2003: 99.)

Results From Applying A Structured SSM Process

The justification for adopting an SSM model was based on Curtis and Cobham’s (2002) five (philosophical) assumptions for its use. SSM is useful to deal with problems that are not ‘out there’. Thus, when one of the modellers started developing the diagnostic model his main problem was that different people associated with the diagnosis had their own views about what the model should be doing. Secondly, the solution to the problem to be modelled had to be intellectual constructs. Thirdly, the problem was not a single problem but a set of interrelated problems. Fourthly, a detailed analysis was required prior to making any decisions on how the systems were to be modelled. Finally, the modeller could not be divorced from the system or its participants. The modeller had to work in collaboration with others.

Although Checkland (1999: A15) states that the seven-step model is somewhat rigid and does not allow a more flexible use of SSM, the researcher was new to the concept of SSM
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and followed the modified seven-step model (Checkland and Scholes 1990:29) which was easy to understand. A rich picture representing the problem was created to stimulate understanding of the problem situation. Using the CATWOE mnemonic (Customers, Actors, Weltanshauung (worldview), Transformation, Ownership and Environmental constraints) a root definition was formulated. At this stage, the researcher carried out a role analysis, social system analysis and political analysis. The role analysis clarified the roles of the client, problem solver and problem owner. The social analysis established the norms and values. The political analysis identified formal authority, intellectual authority, personal charisma (or lack of) and reputation. Based on the problem analysis three conceptual models were developed. The latter models included control structures to meet the criteria of efficacy and efficiency. Two reviews were conducted with the modeller with the conceptual model. During the first review it became evident that the modeller was still lacking information and this was attributed to the lack of the modeller’s capability to persuade team members involved in the modelling project to provide the required information. A second review with the team involved in modelling suggested further issues but a third review indicated that the modelling team had started working together well. Unfortunately for the modeller, the client rejected his solution for the model and this resulted in the modeller leaving the organization.

This experience caused the researcher to reflect on the setback and he realized that there was a lack of a declared-in-advance intellectual framework of ideas suggested in the SSM process (Checkland and Holwell 1998). Such a framework was needed to define and express what could be construed as knowledge about the situation. While the reviews of the work using the seven-step model helped in improving the team work it failed to address the real problem. The client rejected the model as it did not represent the reality, i.e. how it represented the ‘real’ vehicle for which the system was being built.

Based on this analysis, a set of criteria for evaluating the effectiveness of the inquiry process was established. These included:

- Frequent visits to the physical situation (the vehicle) to ensure that any important features were not missed.
- One or more wholeness purposes – One ‘wholeness’ purpose was insufficient to capture the situation completely. For example the focus on team work had diverted the attention of the team from building an accurate model.
- Achieve a shared sense of understanding and familiarity especially when modellers and designers were working in teams.
- Frequent review and verifications to establish coherence among team members and the client (stakeholders).

**Developing A Four-Stage DES Process**

Dick and Swepson (1994) and Dick (1993 and 2000) take a different perspective on how SSM is approached by progressing through four dialectics. The dialectics have a win-win intent to focus on disagreements with a view to turn them into agreements.

Based on a study of Dick’s dialectic SSM process and discussions with Dick, the researcher developed a four-stage inquiry model as shown in Figure 3.
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<table>
<thead>
<tr>
<th>Actual Vehicle (Problem Situation)</th>
<th>Identified Essence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immerse in reality by attending driving and system training courses.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Plan</th>
<th>Diagnostic Model(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Execute test plan.</td>
<td></td>
</tr>
<tr>
<td>2. Construct model(s).</td>
<td></td>
</tr>
<tr>
<td>3. Perform Task Analysis.</td>
<td></td>
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</tbody>
</table>

**Figure 5 The four-stage DES inquiry process (Tay 2003: 114)**

In the first AR cycle the modeller immerse herself/himself in the problem situation. This was done through attending a driving course and a maintenance course for the driving vehicle. This helped the modeller to capture the essence of the vehicle and its various operations.

In the second cycle the modeller constructed a DES for a specific vehicle operation. This is the dialectic between the essence of the vehicle and the model. The modeller is encouraged to forget about the vehicle and focus on the derivation of the DES model.

In the third cycle the modeller performs task analysis – analysing how people do a task, how they act and what things they need to know. This is the dialectic between the constructed DES model and the real vehicle. This cycle is repeated until all the mandatory inspection and repair tasks are completed.

In the final cycle the test plan is verified against the real vehicle. Differences are noted down to take care of differences encountered. This is the dialectic between the test plan and the real vehicle.

**THE IMPLEMENTATION OF AN ELECTRONIC HEALTH KNOWLEDGE MANAGEMENT SYSTEM**

This project was carried out for a District Health Board in New Zealand to implement a series of electronic health knowledge management systems (Orr 2006). The objective of the projects was to increase the capacity of the Board to bring together and have clinical
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information from multiple distributed resources to provide better integrated care and health outcomes. It included implementing several interrelated projects:

1. A single login interface from which all key individual patient demographic information, investigation results, clinical documents and referrals, past treatment events and warnings could be viewed.
2. A patient tracking system for emergency care providing real-time information on a patient’s location, investigation and treatment status.
3. An electronic medical document repository including the migration of a large number of historical clinical documents.
4. Electronic clinical audit facilities focusing first on surgery and helping the provision of clinical outcome measures.
5. Referral status messaging and electronic discharge summaries enhancing real-time information sharing across primary and secondary care environments.

Thematic Concern

The main aim of the research was to utilise an AR process of planning, acting and critical reflection to develop conceptual models to enhance the implementation of Information and Communications Technology (ICT) based health knowledge management systems. While New Zealand has one of the highest rates of ICT enabled healthcare provision it has also experienced significant project failures. So one of the reasons for adopting a different process to implement the ICT systems was the belief that the process developed through this research would help in implementing successful technology-based healthcare projects.

Choosing of Action Research

The research was carried out in teams utilising an AR and reflective learning approach. AR was selected as the methodology due its focus on change and learning, its qualitative, exploratory and theory-building nature, its emancipatory emphasis, its capacity to accommodate researcher participation and its responsiveness and flexibility in complex changing situations (Dick 2001; Reason 2006).

Relevance to Soft Systems Methodology

Although SSM was not explicitly used as a methodology within AR in this thesis, a number of parallels between Checkland’s evolving understanding and development of his own work and the researcher’s conceptualisation of the research process using mnemonics and a concept-reality gap model were observed. Thus SSM was used in the sense-making mode (Mode 2) in this research,

The researcher is a psychiatrist by profession and recorded the parallels between Checkland’s 30 years of development of SSM and the essence of psychotherapeutic practice in one of his papers that formed part of his thesis (Orr and Sankaran 2007). This thesis was submitted as a set of publications that the researcher published during the course of his doctorate. During the initial stages of his research the researcher was under the impression that the focus of his AR would be to resolve some technical integration and configuration issues. He also thought that a structured use of the seven-step model would support the initial focus of the research.

The researcher’s initial expectation was that AR would form the key project stages and would somehow be separated from the daily work of the project. However, as the research progressed, the focus of the AR narrowed to deal with psychological process issues, and
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capability development and AR became integrated with the daily fabric of the project to aid reflective practice.

As the researcher read the works describing the development of SSM (Checkland 1999, 2000a, 2000b, 2005 and 2006) he felt that the broad approach that he and his team took embraced many of the principles that Checkland now identifies as the essence of SSM.

The researcher points to two observations from the paper by Checkland and Winter (2006: 1435):

• That SSM provides a set of principles for intervening in human problem situations in order to bring about improvement.
• SSM is relevant to both the content of the perceived situation (SSMc) and the process dealing with that content (SSMp)

According to the researcher, these two statements echo the essence of psychotherapeutic practice.

Checkland’s SSM evolved to focus on human dynamics, relations, needs, aspirations, perceptions and assumptions to bring about group accommodation of a process. By using the iterative creation of shared models relative to their perceived and current reality SSM facilitates to improve the situation or world they live in.

Psychotherapeutic practice also has similar aims by intervening in human situations to bring about positive change. The goal of the practice is to form an empowering therapeutic alliance that seeks to understand, accept and meet the patient, client or group where they are in terms of their worldview. A key goal of psychotherapy is to help build an agreed model about the factors that have led the person or group presenting in this way, at this time, including identified strengths. This helps to build an agreed plan of required action to move forward which takes into account what is feasible and what is desirable, perceived priorities, preferences and cultural values aiming to minimise weaknesses or vulnerabilities and build on strengths, maximise empowerment, motivation and self-efficacy weighing risks and benefits and recognising potential conflicts and interests. This is an iterative process that has many similarities to the principles of SSM.

The reality-concept gap model that resulted from this research is an example of building a conceptual model to support the AR process. In fact, it could be considered as the framework of language used for this research supported by the SAFE mnemonic. Figure 4 shows the concept-reality gap model.
During the AR cycles used to implement the electronic health knowledge management system a central metaphor used throughout the project was the concept-reality gap shown in Figure 4. This resulted from a visual representation that when an individual or system faces a stressor or change there may be an initial drop in the functioning before a hopeful reorganisation, improved resilience and capability to return to the baseline. This phenomenon can be observed in concepts such as the reengineering curve, the death valley of change, crossing the quality chasm or moving through a grief process (Committee for Quality of Healthcare 2001; Elrod and Tippett 2002, Kelly and Tucci 2001).

While an initial drop in performance may be acceptable in a business process reengineering process with a belief that it will lead to increased productivity it may be detrimental to patient safety in a healthcare situation. This may result in the abandonment of the new process to return to the original trusted process. Failure to appreciate the magnitude of this ‘acceptance’ gap could lead to full or partial failure of ICT implementation in a healthcare system (Glouberman and Mintzberg 1996; Heeks et al. 1999, Orr 2000).

While you could try to jump from reality to concept in one go it might result in a crash-and-burn situation in a healthcare scenario. Therefore, an incremental process is needed to move from reality to concept using a stepping stone approach as shown in Figure 4. But the stones need a firm foundation and this was provided in the research through the use of mnemonics such as S.A.F.E. (Scalable Affordable Flexible Equitable) projects. The combination of a metaphor and a mnemonic was very useful to implement the change processes required in this project. Using AR cycles helped to support the incremental nature of the implementation.

**DISCUSSION**

Greenwood and Levin (2007: 59) state that a ‘systems approach necessarily underlies AR in all its manifestations. Both rely on an interconnected and holistic view of the World’. They add that AR also tries to transform society into more open systems.

The principal author of this paper has also used open systems approaches such as ‘search conferences’ in his own doctoral work using AR. Greenwood and Levin (2007) also
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advocate the use of search conferences within a pragmatic AR process. A search conference fits in with the democratization goals of AR.

Flood (2001) differentiates between systems thinking and systemic thinking by arguing that while systems thinking takes an objective stance, systemic thinking takes a subjective stance. He argues that SSM is a form of systemic thinking as reality is perceived through people’s interpretation of their experiences. Flood also states that ‘Action research carried out with a systemic perspective in mind promises to construct meaning that resonates strongly with our experiences within a profoundly systemic world’ (Flood 2001: 143).

SSM and AR have a close connection as SSM itself was developed through an interpretative AR project looking into situations existing in the real world. Checkland and Holwell (1998: 22-23) refer to the version of AR proposed by Argyris et al (1982) where the crucial elements of the AR are ‘a collaborative process between researchers and people in the situation; a process of critical inquiry; focus on social practice; and a deliberate process of reflective learning’. But they feel that conventional AR misses ‘a desired-in-advance intellectual framework of ideas, a framework in terms of which what constitute knowledge about the situation researched will be defined and expressed’. They feel that without this framework AR might lose its rigour.

Researchers in a doctoral program conducted by Monash University (Sarah et al 2002) have utilised systems thinking methodologies in conducting AR. The first batch of candidates who used systems thinking in their AR set up their research using the FMA (framework, methodology and action) model advocated by Checkland and Scholes (1990). They adopted the suggestion by Checkland that a desired-in-advance intellectual framework is required in AR projects. Figure 7 shows the FMA concept.

![Figure 7 Elements of research (Source: Checkland 1975: 3)](image-url)
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Table 1 shows a comparison between a general AR process and the SSM process.

<table>
<thead>
<tr>
<th>SSM</th>
<th>Action Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problematical situation</td>
<td>Fuzzy problem</td>
</tr>
<tr>
<td>Taking purposeful action</td>
<td>Taking action to observe and reflect on the situation</td>
</tr>
<tr>
<td>Strategic questioning</td>
<td>Questioning as part of the reflective process</td>
</tr>
<tr>
<td>Participatory</td>
<td>Mostly participatory</td>
</tr>
<tr>
<td>Taken into account people affected</td>
<td>Empowerment</td>
</tr>
</tbody>
</table>

The main difference seems to be that SSM advocates the use of a declared-in-advance intellectual framework while AR may not always take this approach. There are also other ‘administrative’ reasons why such a framework would be useful to doctoral researchers in academia. When research is conducted for academic purposes it is mandatory to seek ethics approval for the research. In these situations a declared-in-advance framework would be very useful to help in the approval of AR as the research methodology. It also helps candidates who are often required to declare details of their methodology by the administrative processes that are adopted by universities who often use the scientific model of research administration. In the university where the principal researcher is now situated the doctoral assessment process which acts a gateway to confirm candidature would pose significant problems to candidates who use AR in more flexible ways.

From the expert systems case described in the paper it was evident that the lack of an intellectual framework resulted in initial setbacks with the modelling, and the development of a four-stage DES inquiry process that served as the intellectual framework in the second round of applying SSM helped to structure the research better. In the knowledge management case described in this paper the metaphor of the ‘reality-concept’ gap could be considered as the declared-in-advance or developed framework that guided the research.

Although systems thinking and AR go hand in hand there are some limitations in applying SSM in management research where a solution is expected from the research. Checkland and Morris (2006: 1435) state that SSM is a ‘methodology that provides a set or principles for intervening in human problem situations in order to bring about what would be judged to be “improvements”’. If the aim of practitioner research is to make the practitioner into a better researcher then processes such as SSM would be very helpful. However, when the motive of the research is to find solutions or develop a product questions could be raised as to the effectiveness of a process like SSM as well as AR. Another issue that is often faced by researchers using AR and SSM is when do you stop? You can go on learning endlessly with these methodologies. When these are adopted to do a doctoral thesis there are time and resource limitations limiting the duration of the project. This issue is out of the scope of this paper but has been discussed in detail by West and Stansfield (2001). Their paper is also shows how structuring action research projects using the FMA model is useful in many respects.

The two research projects described in this paper used SSM in different ways. The first project which was carried out by a systems engineer took a different view of applying systems thinking to software development but essentially the researcher was looking for a solution to minimise the number of logic faults occurring in a modelling process. The application of SSM helped not only in solving his problem but also contributed to better practice where the dialectic model of SSM he adopted resulted in a process of ongoing
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learning in his practice. Thus, it also fulfilled the aims of SSM being a learning process in human activity systems. The second project carried out by a psychiatrist did not directly include SSM but recognised parallels between SSM and his own practice. SSM became a sense-making system. One can say that there are philosophical similarities between SSM and AR as applied in a therapeutic practice environment. It is interesting that the researcher thought of SSM as a process to implement an information systems project but in the end realised that it is a process that promotes better understanding. SSM, like AR, can also be used as a meta-methodology to help thinking about the research problem and gain better understanding before other methods are adopted.

CONCLUSIONS

Although there are many similarities between the principles of AR and systems thinking (especially soft systems thinking) the process might take long and may not be goal seeking. However, incorporating systems thinking approaches such as search conferences or soft systems methodologies could be powerful when they are used in an AR project to improve the researchers’ practice, enable stakeholder buy-in into the changes being proposed as a result of the AR intervention and incorporate a declared-in-advance framework of ideas to pursue AR more effectively. Some more practical versions of SSM such as the dialectical model described in the expert systems project could help researchers use a systems approach more effectively towards achieving a solution in an AR project. The expectation from dialectical SSM approach is that a content engineer (or a modeller) should be able to appreciate the fact that knowledge acquisition is both an opportunity and a constructive modelling process that enables him/her to gain a better insight of a domain via the process of articulating, structuring and critically evaluating the model for that domain. The FMA concept to undertake any research advocated by Checkland could come in handy for action researchers to structure their research.

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EVOLVING TO SUSTAINABILITY

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ABSTRACT

Humanity needs a conscious transformation, called a paradigm shift, to a system based on sustainable principles. Previous shifts of the magnitude of the Agricultural and Industrial Revolutions allow us some insight into the process. The U.S. dollar has become weak due to debt. In the U.S. and Europe, financial crises in the private sector are raising havoc in the public sector. Growing environmental problems are forcing institutions to be more responsive to limits. China seems to be racing as fast as it can to make the same mistakes as the U.S. and Western Europe. This time there does not appear to be a bottom to the economic downturn; the stages are: slowdown, recession, meltdown, depression, collapse, free fall, transition, transformation. Human nature necessitates freedom within enabling constraints. Women should be respected as equal to men. Ideas for sustainable agricultural practices and viable urban communities lead to an ecotopian economic model of plenitude, prosperity, and social stability within a healthy, nurturing environment planetwide.

INTRODUCTION: THE WORLD AS WE KNOW IT

Out of the rubble of World War II, the United States emerged as the dominant economic colossus. Building on the world trade foundation of the British empire of the previous two centuries, the U.S. dollar replaced the British pound as the world currency that defined economic value. Now the economic power and the political dominance of the U.S. as the World Superpower seems to be waning. Flaws in the taught version of reality are making it increasingly difficult to hold that reality together. With the Cheney/Bush team in control, the U.S. mega-government has gone from having a healthy budget surplus and the world in virtual peace to a multi-trillion dollar deficit and much of the world in a war/terror consciousness.

But the fundamental reality of the dominant American economy has assumed a “whatever you can get away with” mentality – for example, you assume you can throw waste into the river. The multi-national corporate industrial model has assumed that every pristine natural environment is ripe for abuse for the sake of profit.

And, the collective American consumer has mortgaged the future for short run conspicuous consumption without regard to accumulating debt.

Up through 2005, the U.S. economy was bolstered by the inflating value of residential real estate. But what if the dominant economic paradigm is built on half-truths?
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Eventually the half un-truths will accumulate to catch up and overwhelm the dominant dollar and its beneficiaries. Then, the house of cards, the Tower of Babel, will get caught up in its own troubles, and come tumbling down.

Stafford Beer said, “Theory is the only reality countenanced by our culture”. The U.S. economic machine was built on a series of ideas, a sequence predicated on accepted truths about the power of money and the benefits of growth, and the value of an oil/fossil fuel based business machine. Four months before the assault on the World Trade Center in New York City, Dick Cheney said that “conservation may be a sign of personal virtue, but it is not a sufficient basis for a sound comprehensive energy policy”. But the dominant economic model that Cheney defends does not bode well for the future. With a global population of 6.5 billion and continued growth expected, the greed-based economy has turned the planet into a cesspool. But nature bats last.

There are times in history when forces for change precipitate institutional transformation. About 10,000 BCE, the Agricultural Revolution brought about the emergence of fairly reliable food, which led to the development of cities, fast growing populations, and the dominance of the human on the natural landscape. By 1750, emerging technological innovation drove the Industrial Revolution and the acceleration of the tools of mass production. Now the different cultures of the planet are confronted with the cumulative problem of having exceeded the carrying capacity of the planet. Global climate heating due to excessive production of carbon dioxide into the atmosphere is melting the glaciers and the polar icecaps, raising the ocean levels significantly, and creating heat sinks in the temperate mid-latitudes at an increasing and alarming rate.

The only hope for long term human viability is a Sustainability Revolution of the magnitude of the Agricultural and Industrial Revolutions. Western Civilization as we know it cannot go on forever. The automobile based economy is a dinosaur that has a lifespan of little more than a century and cannot survive for much longer. There are many things of benefit that can be created from fossil fuel petrochemicals. Putting them in an engine and exploding them for the sake of moving a two ton vehicle a few miles as fast as a human can is wasteful and shortsighted. Auto congestion is a whole other problem.

While the ecological picture is a pathetic disaster to the point where humans have exceeded the carrying capacity of the planet, it is the financial powerhouse that is falling apart and must be replaced by the emergence of a healthier paradigm of sustainable ideas that are more in tune with the reality of nature.

The next stage of human history will not be easy. Ever since the collapse of the Bear Stearns hedge funds in June 2007 and the run on the British mortgage bank Northern Rock in November, there have been increasing signs that the global economic machine is full of internal flaws and they are working against each other, making it increasingly difficult to maintain the current growth model. Because of the Internet spreading throughout the world, and rapid electronic telecommunications, a sequence of fast, accelerating instabilities will cause the disappearance of various foundations of the
dominant western economy. On the day of the U.S. holiday for Martin Luther King Jr., January 21, 2008, a hiccup in world stock trading led to a drop of 3% in the stock exchanges of Shanghai, Hong Kong, India, France, Germany, and Great Britain, all within a few hours. The U.S. Stock Exchange did not drop because it had taken holiday, and first thing the next morning the U.S. Federal Reserve lowered its prime interest rate as a psychological ploy to signal (con/manipulate) the U.S. market. The rapidity of the sequential drop of the stock exchanges around the world is a measure of just how connected the global economy has become, and how fragile it is.

That event may turn out to be the equivalent of the collapse of the Berlin Wall, in 1989, which marked the beginning of the end of the Soviet Empire.

The time lag for the U.S. government to make a decision of consequence is months, and events are going to be emerging in time frames of days and even minutes around the world, and the Cheney/Bush administration is going to be mostly standing by helplessly. The stages of transformation of the U.S. economic system look like they will be:

slowdown,
recession,
meltdown,
depression,
collapse,
free fall,
transition
and transformation.

This analysis looks at the problems with the dominant corporate industrial economic myth, the consequences of seeing the planet as a cesspool for personal and industrial waste, the special problems created by the emergence of Brazil, Russia, India and especially China (BRIC), and the components of a healthy ethos for building sustainable communities in the future. In hopes that we have a future.

**ANALYTICAL TOOLS: TIME LAGS – DETECTION AND RECOVERY**

- Detection Lag: the period of time from when an event or change in status actually occurs until the point in time that its control system detects that a significant change has occurred, triggering a decision to respond.
- Recovery Lag: the period of time from when a control system has made the decision to respond, to then go through the controller’s act of change, and then the period of time that it takes for the system to follow through in reaction to the controller’s action. (See graphic in Platform for Change by Stafford Beer, page 430, Underlying problem in controlling an economic variable, obscured by other mechanisms)

For example, some time in early January 2008, the Cheney/Bush administration and the leaders of the Congress came to the conclusion that the U.S. economy is in so much trouble that they should develop a stimulus package. The stimulus package that included a taxpayer rebate was agreed upon and signed into law in late January, and taxpayers
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began to receive their checks in May. Taking more than four months from decision to implementation seems like a long time.

PART I: ELEMENTS OF THE PROBLEM
STORMY ECONOMIC SKIES AHEAD

The corporate industrial economy is in trouble financially, fiscally, environmentally and socially. This section focuses on the private sector financial and the public sector fiscal difficulties; the following section focuses on long term environmental problems; the social issues will be addressed implicitly in the second half of this analysis.

A Quick History: Europe in the year 1000 was mostly unoccupied forests. By 1500, most of the land was owned, the forests cut down for agriculture. Populations were increasing and converging into growing towns. Trade and new technologies spurred industrialization, higher density cities, crowding and motivation to immigrate to the new Western Hemisphere.

In the 18th and 19th centuries, the U.S. with its vast open spaces and abundant natural resources offered unlimited opportunities. By the end of the 19th century, economic powers consolidated and dominated the political process and the news media. The country shifted from a rural orientation to urban-suburban with the help of electricity and the automobile.

After the First World War, Great Britain lost its global dominance as distance travel shifted from ship to airplanes, and the British pound was replaced by the U.S. dollar as the standard for currency, exchange and value.

The U.S. economic decade was known as the Roaring 20s. Europe was rebuilding from the devastation of the War, and the U.S. was expanding industrial capacity and emerging as a world trade power. The fastest way to achieve wealth was to leverage stock – buy, use a paper profit to buy more, in cycles of growth. People built enormous paper profits – until 1929. Then uncertainty grew and sellers started calling in the buyers. Banks had loaned out their deposits, so they couldn’t pay back their depositors. The only way it works is if most people have so much confidence in the financial institutions that they don’t all ask for their money back at the same time. When they do, it is called a run on the bank. That happened in 1929, and it led to a margin call on the stock market – stocks that had been pyramiding on each other’s value lost their foundation and collapsed in worth.

During the Depression of the 1930s, the U.S. shut down industrial plants as unemployment rose. The growing conflict of the beginning of World War II led President Roosevelt to make the Lend Lease commitment to Great Britain, and stimulate the rejuvenation of underutilized industrial capacity. By the end of World War II, much of Europe and Japan had lost most of their industrial infrastructure. The unharmed U.S. heavy and light industry blossomed as it shifted to consumer goods. The U.S. political process and media were dominated by major corporate industrial interests, and the
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emergence of television provided a new vehicle for creating a predominant definition of reality, as people pursued the corporate/bureaucratic job to finance a middle class lifestyle with a suburban home, cars and the latest electronic gear and appliances.

In the aftermath of the Depression, the U.S. Congress legislated new rules and regulations for the Federal Reserve and the Securities and Exchange Commission to minimize the chance of 1929 ever happening again.

The Current Financial Situation: The driving force of the corporate industrial economy is debt. Companies take out loans, expand their capacity to produce, generate revenue, and nurture growth.

But the bottom line for the corporate industrial economy is greed: the pursuit of money for its own sake (profit at any price). So after World War II, financial geniuses discovered new ways to benefit by getting around the rules. During the 1980s, junk bonds and savings and loans were designed in such a way that seemingly profit could be generated while minimizing potential risks; both junk bonds and S&Ls exceeded their controls and were brought back down to earth.

Until 1999 the Glass-Steingold law (1934) had separated investment banks and commercial banks; Glass-Steingold’s repeal created the environment for investment banks to become involved in high risk, unprotected behavior – without the controls built in to the commercial banks.

From the mid 1990’s to 2005, one guaranteed way to make a paper profit was in residential real estate, as housing in the U.S. and Europe doubled and tripled in value. The banking and mortgage industry found that they could bundle a package of real estate loans and sell them as securities (securitization) on the stock market and they would increase in price on the open market. As long as the original loans were being paid, there wasn’t any risk, and enormous profits. The mortgage companies lowered their standards for approving residential loans, approving loans for people who really couldn’t demonstrate a long term ability to meet their financial obligations (subprime) and approving loans with little down payment and adjustable rates based on the then-low interest rates.

In 2005, the bottom started to fall out of the residential market in the U.S. and Europe. Sky rocketing housing prices started to fall. People with stretched incomes became delinquent in their monthly mortgage payments, and faced foreclosure. Those mortgage-based securities started to go sideways, and then housing prices (paper values) started to drop, and new home owners, and home owners who had refinanced based on the increased paper values of their houses, discovered that their houses were worth less than their mortgages (upside down), they couldn’t sell for nearly what the paper said they were worth, and they became delinquent, faced foreclosure, and started to walk away, making their mortgage and the securities worthless.
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Last July, Bear Stearns, the fifth largest investment bank in the U.S. saw two of its hedge funds go under. Then in March 2008, it had lost so much paper value that JPMorgan Chase bought it for pennies, only because the Federal Reserve guaranteed it would back Bear Stearns’ obligations of $30 billion with taxpayer funds.

In November 2007, a British bank, Northern Rock, had a run (the first British bank run in over 100 years), which was stopped after several days only because the British government guaranteed the deposits, and eventually took over the bank and an obligation that has grown to 50 billion British pounds ($100 billion).

The banking structure is based on loans, and the expectation that a business can generate enough revenue to exceed the cost of the loan. Since Bear Stearns got in trouble last summer, banks have gotten tighter about their willingness to give out loans, even to other banks, creating what is known as a liquidity crisis. The Federal Reserve has two tools to free up funds: lowering interest rates and making loans itself. Between mid-January 2008 and the end of April, the Fed lowered its prime rate from 4.25 to 2.00, and made $400 billion available for loans to banks in an attempt to free up liquidity. Sooner or later, the Fed is going to run out of interest rate to drop any further. When the U.S. Federal Reserve lowers the prime interest rate, the rule of thumb has been that it takes six months for the decision to percolate down to the other interest rates and thereby stimulate economic activity. It is a fundamental conclusion of this analysis that each time the Fed lowers the prime interest rate it has less of an impact on the real economy (“Main Street”) and is only responding to the consciousness climate of the stock exchange (“Wall Street”).

But there is another problem: the almighty dollar isn’t as strong as it used to be, in terms of buying power compared to other currencies. Why is that?

Since the end of World War II, the goal of almost every other country has been to sell goods in the world’s #1 marketplace, the U.S. Up through 1975, U.S. productivity was so dominating that it had an export advantage (current account surplus) with other countries (except for oil exporters). But because of that tremendous consumer consumption, the U.S. lost that trade advantage, but made up for it by selling knowledge and financial services to retain a net positive balance for another decade. Then during the 1990s, U.S. continued its high consumption pattern while importing more, especially from mainland China. This pattern established a perpetually growing U.S. current account deficit.

Now, basically nothing but debt is holding up the dollar, and it is only a matter of time before it is replaced as the international medium of exchange, as it replaced the British pound after World War I. It will probably be replaced in the short run by the euro of the European Union, but the same financial termites are eating away at that banking system – European banks are carrying a lot of those U.S. housing mortgage-backed securities that used to generate a profit and now are questionable or worthless.

From the Economist, April 26, 2008, “UBS made public a summary of an internal investigation into the mistakes that led it to write down a total of $38 billion, the most by any European bank hit by the subprime crisis… Other banks added to the list of woes
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stemming from the mortgage markets. Credit Suisse, UBS’s rival, swung to a loss in the first quarter largely because it took $5.0 billion in writedowns. Bank of America said its first-quarter profit had fallen by 77% compared to a year ago, and that it would increase its provision for credit loses by $5 billion. Citigroup booked another $13 billion in writedowns and made a quarterly loss of $5.1 billion. And Royal Bank of Scotland said it needed to raise $24 billion, about a third of its market value, in a rights issue to help protect its core capital”.

The next international currency could well be the Chinese yuan, but it faces a different set of problems.

On a personal level, too many people who consider themselves to be Middle Class American are using their credit cards for their house payments, and have accelerating credit card debt. The debt pain and disease is spreading from real estate, finance and construction to retail, restaurant and food service, and beyond to the various support networks that service those industries. According to a recent New York Times article, “Because retailers rely on a broad network of suppliers, their bankruptcies are rippling across the economy. The cash-short chains are leaving behind tens of millions of dollars in unpaid bills to shipping companies, furniture manufacturers, mall owners and advertising agencies. Many are unlikely to be paid in full, spreading the economic pain.”

The Current Fiscal Situation: During the Depression, President Roosevelt brought in the Keynesian version of national governmental policies to make efforts to steer the economy. Post World War II also brought ideological competition between the command-control Soviet system and the free enterprise open trade of the U.S and Western Europe - government protection for the large corporations. This rhetorical battle put the U.S. economy on a permanent wartime footing, perpetuating devoting economic resources to maintaining arms development and selling arms to belligerents around the world. (When the U.S. and its allies attacked Iraq in 1991, Iraq’s most advanced weapons had been provided by the U.S. during the recent Iraq-Iran war.)

The world will never know how history might be different if Al Gore would have won the U.S. Presidency in 2000. The surplus annual budget might have been maintained and the response to 9/11 might have been limited to a concentrated assault in the mountains of Afghanistan to isolate and capture Osama bin Laden.

Instead, 9/11 gave the Cheney/Bush administration the justification to invade Afghanistan and Iraq, and escalate governmental obstruction of the daily working life of the domestic economy and society at great cost to everyone. The Cheney/Bush administration is spending money like there is no tomorrow. First the tax cut, which mostly benefits the richest. Then the Iraq fiasco, which is off-budget, so there is no telling what it is actually costing, in addition to 4000 U.S. military lives, hundreds of thousands of Iraqi lives, millions displaced, and many more millions distraught and fearing for their lives and the prospects for the future.
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In some ways, the worst thing about the Cheney/Bush arrogance is their indifference about the future implications of their actions. In May, U.S. taxpayers received a stimulus of up to $600, as though that is going to rejuvenate the U.S. retail economy. Where does that $150 billion stimulus package come from? From the budget deficit – from future taxpayers. Where does the Fed’s $400 billion loan package come from? If the Fed or the Treasury comes up with a program to back the risk of the unpaid housing mortgages, who is going to pay the bill? The U.S. taxpayer. In the name of Republican frugality, the Cheney/Bush administration is ruining the U.S. dollar. There is nothing holding it up but debt.

In California, the Governor’s January state budget for the upcoming fiscal year was over $120 billion, but has since been identified with first a $14 billion revenue shortfall, that has recently grown to an $20 billion shortfall - initial state taxes on income, sales, property and corporations are all less than expected in the January budget. In two weeks, the Governor’s traditional May Revision of the upcoming Budget will send shock waves for further cutting at the state level in every department.

In the public sector, they should cut salaries, not jobs. In the public sector, salaries and pensions have gotten out of control. The public sector salaries need to be drastically deflated, rather than further increasing taxes and causing more inflation to balance the budget. For the State of California to regain control of its fiscal survival, there needs to be an initiative petition for a state proposition for cutting back public sector salaries to a maximum annual salary of $50,000 with defined benefits. And, repealing the State Public Employee Collective Bargaining Act (1975) that applies to most state and local public employees, and is the reason why budgets have climbed so much.

**Assessing the Global Economy:** This is a ballpark attempt to create a benchmark for total aggregate wealth on the planet (in January 2008 trillion dollars) including the annual Gross Domestic Product, plus individual consumer wealth, industrial plant, infrastructure, and potentially accessible natural resources. Perhaps the U.S. Central Intelligence Agency or the World Bank has done an assessment like this, but their version is probably more static. The point is to establish a baseline for future change, so that as the economy goes through turbulent adjustments, it is possible to reassess whether something is going up or down, and indicate possible courses of action.

These are ballpark estimates, a baseline for comparison:
U.S. $200 trillion total value, $14 trillion annual gross domestic product;
European Union $240 trillion total value, GDP: $16.8 trillion; China $150 trillion total value, Japan $100 trillion total value, Middle East $100 trillion total value, Russia $50 trillion total value, Canada $10 trillion total value, Brazil $10 trillion total value, Australia $10 trillion total value, India $5 trillion total value, Venezuela $5 trillion total value, the rest of the world $100 trillion total value. Aggregate total global value: $1,000 trillion.

Prognosis: U.S. falling a lot, EU falling behind the U.S. (Italy, France and Spain are in particular trouble), Japan falling behind the U.S., India falling behind the U.S.; China
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expanding short run, Russia, Middle East, Australia, Canada, Brazil and Venezuela expanding short run to meet resource demands by China.

**U.S. Economic Avalanche:** while nothing happens all at once, sequential events accumulate. For example, in June 1989, East Germans discovered that they could sneak across the border to Czechoslovakia and then go into West Germany, and a trickle became a flood, and in November the Berlin Wall came down and the Soviet system with it.

The house of cards of the corporate industrial financial system started to fall with the collapse of the Bear Stearns hedge funds in July 2007. The British treasury is backing Northern Rock, but it is only one medium sized British bank. The British government cannot afford to support another over-extended bank, and they are all over-extended.

In March 2008, the U.S. Fed agreed to back JPMorgan Chase for buying Bear Stearns, but real estate in the Manhattan financial district is beginning to lose force and people in related financial businesses are losing their jobs. Then they will lose their homes, and the New York/New Jersey housing industry will go the way of California, Florida and Michigan.

People are falling behind on their car payments and their credit cards, to try to make up their house payments. Once this downward cycle has started it feeds on itself. Like being in the middle of an avalanche, the Cheney/Bush administration can only talk about things they could or should have done but are way too late to do anything about but watch. Most of the decent policies they should have considered would take months or years to implement. Some would have required ethical standards that this administration wouldn’t understand anyway. The U.S. pay-the-market model of the 20th century has many problems for housing and transportation.

For comparison, here is an analysis of what life was like as the Soviet Union collapsed (from Kunstler’s analysis of Dmitry Orlov’s book, *Reinventing Collapse*): “For all of its gross faults, Soviet Russia was ironically better prepared for economic collapse and political turmoil than we will be. For one thing, all housing there was owned by the state, and allocated under bare nominal rents, so when the economy collapsed, people just stayed in their apartments. Nobody was evicted. There was scant private car ownership in pre-1990 Russia, so gasoline allocation problems did not paralyze movement. Train service was excellent and cheap, and the cities all had a rich matrix of underground metros, on-street electric trams and trolley-buses, which continued to run even when central authority flickered out. There was no suburban sprawl to strand and isolate people. Official Soviet agriculture was such a fiasco for half a century that the Soviet people were long-conditioned to provide for themselves. For decades, 90% of the food was coming from tiny household gardens. Very little of the success of the post-Soviet transition is set up for citizens in the U.S.”

As the next president is elected, growing problems are emerging. In a sequence of stages similar to what is already happening to Bear Stearns, a major financial institution like
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Citigroup or Bank of America will get into serious trouble, then it will be bought by another financial company, most of its jobs eliminated, and a lot of what it had been doing won’t be done any more. Then, the second company will wobble and fold, partly as a result of its inability to do the first company’s paper work, but also because of the collapsing mortgage industry and subprime problems and illiquidity of the banking industry in general. This will create another step in the domino effect, which topples smaller banks and financial institutions as well as retail and industrial businesses they have been servicing. CPAs will have more work than they know what to do with.

The dollar, the pound and the euro will lose value, and the price of oil will shift to the Chinese yuan, the most stable currency around. As the dollar weakens, the price of gas will climb to $10 a gallon, and then $20 a gallon.

While there will be some civil unrest, as thousands and thousands of middle class people lose their jobs, their homes, and their cars, for the most part the U.S. remains calm in the shared realization that the economic meltdown is hurting everyone, all over the country, not just the entitled college educated white middle class that have been living high off of the rest of the planet since the 1950s. In New York City, Boston and Chicago, people abandon their suburban homes, and move into vacated downtown office buildings. They organize buying clubs to purchase basic foods and commodities, and talk about ways to survive the upcoming winter cold. Regardless of who becomes President, the shanty towns that grow in every major city will be so reminiscent of the Great Depression of the 1930s that they will be known as Bushvilles, not Hoovervilles.

People who have relied on their book learning and financial intelligence to be successful enough to pay other people to meet their needs start thinking about how to work within their newly discovered community to build a network to cooperatively meet their personal and social needs.

THE PLANET AS A CESSPOOL

According to Canadian archeologist Laura Smith, it now takes 20% longer for human tissue (skin, muscle, bone) to decompose than it did 100 years ago. Some of that is due to preservatives in our food, some of it is due to junk in our environment.

During the 20th Century, humankind has exceeded the carrying capacity of the planet. We have 6.5 billion people now, and are continuing to grow. It is what Garrett Hardin identified as the “tragedy of the commons,” that each individual feels it is our right to use as much of the natural resources as we want or can purchase. As corporations or even as nations, humans have exceeded the environmental regrowth capacity for forests and fish in the sea of many countries. The quality of water and air in too much of the planet is polluted. A reciprocal problem is that we are diminishing the amount of open space and wilderness, and species are disappearing as a consequence. And then there is climate change. In addition, there are several specific problem areas (information for this section is taken from The World Without Us, by Alan Weisman):
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**Nuclear contamination**: with 441 operating nuclear power plants around the world, it is amazing that there have been only two known cases of near disaster: Chernobyl and Three Mile Island. TMI was contained, and actually Chernobyl was partly contained. Even so, contamination from Chernobyl was so severe that three days later increases in radioactivity were detected in the atmosphere in Sweden, leading to international concern in response to initial denials by the Soviet government. Now the area is contaminated for miles around, with toxic levels of radioactivity for centuries.

With increasing demand for oil worldwide, and pressure for greater use of energy by China and India, China is planning to develop nuclear power on a large scale. Repeated denials by the Chinese government during the developing SARS pandemic does not engender confidence that a nuclear accident would be admitted by the Chinese government until long after a problem had emerged.

And then there is the question of what to do about the waste from the 441 existing plants. Altogether they annually produce 13,000 tons of high-level nuclear scrap. In addition, the U.S. alone generates 3,000 tons of spent fuel a year. So far, only shortterm solutions have been developed, and the plan to put the waste in 55 gallon barrels and dropping them in the ocean would only lead to turning the oceans and fish into carcinogens.

**Plastics waste stream**: Since World War II, commercial science has been devoted to the production of different forms of plastics such as acrylic, nylon, polyester, polyethylene, polypropylene, polystyrene, and polyvinyl chloride. Eventually these virtually non-destructible products enter the waste stream, and because they are light, the wind and water carry the waste to the oceans. Billions and billions of tons of plastic in the oceans. Birds and fish think the colorful plastics are food. Water currents pulverize them, they turn to powder, plankton swallow them, and they enter the food chain as they are clogging up the plankton’s digestive tracts and bringing pollution inside all of the fish that depend on plankton as a primary food source.

**Farming Pollution**: “Nearly 12% of the planet’s landmass is cultivated, compared to about 3% occupied by towns and cities…” Pesticides, heavy metal toxins and persistent organic pollutants (POP) that show no sign of degrading are contaminating our soils and entering the food chain. But it is the heavy dosages of artificial chemical fertilizers that have a long term impact on our drinking water. “The worst impact of phosphates and nitrates, however, isn’t in fields, but where they drain. Even more than a thousand miles downstream, lakes and river deltas suffocate beneath over-fertilized aquatic weeds. Mere pond scum morphs into algae blooms weighing tons, which suck so much oxygen from freshwater that everything swimming in it dies. When the algae collapse, their decay escalates the process. Crystalline lagoons turn to sulfurous mudholes; estuaries of eutrophic (oxygen depleted) rivers balloon into gigantic dead zones. The one spreading into the Gulf of Mexico at the mouth of the Mississippi, charged with fertilizer-soaked sediments all the way from Minnesota, is now bigger than New Jersey”. What the U.S. calls standard farming practices is not sustainable, it is deadly.
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Corn Ethanol is a mistake: Cheney/Bush’s invasion of Iraq, subprime housing mortgages and corn ethanol are among the dumbest things the U.S. is doing. The obsession with corn for ethanol has turned corn into the number one cash crop, with states like Iowa devoting so much land to corn production that they have to import food and are not self-sufficient, and eliminating land availability for other crops. Over ten percent of the corn crop is currently used for ethanol. The growth and production of the corn requires transporting seeds, making fertilizer, herbicide and insecticide, as well as operating tractors and other farming equipment - processes that all require fossil fuel. The conversion of corn into ethanol through industrial fermentation, chemical processing and distillation also uses large amounts of fossil fuels, not to mention the transportation of the materials via diesel trucks. And then there is the long term impact of mining the soil, with repeated applications of fertilizer and pesticides reducing the productive life of the U.S. farm belt, and contributing to the pollution described above. U.S. corn for ethanol means that U.S. farmers are converting from soybeans to corn, so Brazilian soybean farmers are expanding into cattle pastures, so cattlemen are cutting forest in the Amazon. Anywhere on the planet, biofuels only increase the carbon footprint, causing more global warming. The only way that ethanol is a positive is in converting cellulosic biomass waste, and scientists haven’t discovered the enzymes to make that feasible yet.

TRUE COST PRICING

In a post-industrial, ecologically responsible, stable state economy, people devote over a third of their budget to food, and materials are quite expensive.

By comparison, in the corporate industrial economy, maximum effort goes into minimizing the producer’s costs for manufacturing goods. The process is proprietary so that the producer can charge a lot. Natural resources are obtained without respect to environmental destruction. Waste is absorbed by the environment or paid for by the taxpayer. And the primary purpose of the political process is to minimize the producer’s obligation to be responsible for the consequences of production and consumption.

The U.S. Environmental Protection Agency was set up by the Nixon Administration and its real mission is to maximize the likelihood that producers can pollute and not be responsible for their waste.

The real cost of an automobile should take into account the total cost of the pollution of mining the metals, creating the roads, adding to the congestion and inconvenience, the law enforcement, and the incarceration (half of the people in U.S. jails are convicted of auto related crimes). In current dollars, a car should cost a minimum of $200,000 (about ten times its current price).

In the current economy, most of the real cost of goods is born by the public, the environment and the future. The political debate is always about who should benefit and how much who should pay.
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BRIC: BRAZIL, RUSSIA, INDIA AND CHINA

Traditional economists looking at the prospects of the U.S. going through at least a recession are heartened by the prospects of the emergence of traditionally underdeveloped countries doing really well, and bringing the global economy out of a complete collapse. At the top of the list are BRIC: Brazil, Russia, India and China.

Since this analysis is focusing on the ability of an economy to have long term sustainability, these countries should be evaluated by three criteria: economic equality, ecological self-sufficiency and political openness.

The economic equality has a straight forward measure: The Gini coefficient is a summary measure of income distribution, ranging in a value between 0 and 1. Zero would signify that income is perfectly equally distributed, and 1 would indicate that all income is concentrated in the hands of a single individual. Examples of relatively equal economies include Sweden, 0.25, Japan, 0.25, and Germany, 0.28. Examples of high inequality include Brazil, 0.59, and Mexico, 0.55. In 1983, China’s Gini index was 0.28, but by 2004, it had increased to 0.47, surpassing the U.S.’s .45. Russia’s is .41, and India’s is .37.

Ecological self-sufficiency is more complex. Brazil is still a mostly underdeveloped country. While the relative numbers of growth are good, the self-sufficiency is narrow, with a large portion of the society living a subsistence existence. Worse, the Amazon rain forest is one of the most depleted ecosystems on the planet, and there is very little effort for making the soil last more than a couple of seasons following the destruction of the rain forest by slash and burn.

According to The Economist (3/29/08), Russia’s Mr. Putin “has done much to stoke fears of a new cold war. He has suppressed democracy at home and acted more aggressively abroad. Long-range bombers once again lurk close to NATO countries, and the rust is being taken off other bits of Russia’s military machine. Russia has used oil and gas as a political weapon, periodically cutting off fuel supplies to neighbors”.

India’s economic surge is completely dependent on providing services to the U.S. and Europe; if those economies go down, they won’t be needing the inexpensive versions of services the Indians are providing.

China’s economy is taking over the world, but it is an extremely short time frame of success, at great ecological cost. It is significant that the Chinese Gross Domestic Product has increased by 7% per year for the entire 1978-2005 period, the most sustained period of rapid economic growth in human history. However, according to a December 2000 report by the U.S. Embassy in Beijing, pollution costs the Chinese economy anywhere from 3 to 8 percent of GDP each year. In addition, ecological damage potentially costs another 5 to 14 percent. Even at the low end of these two estimates, environmental damage is roughly equivalent to annual economic growth, meaning that the economy is
producing little or no new net national wealth. It is systematically destroying the sources of its future wealth. China is the opposite of ecological self-sufficiency.

China’s dirty technology has global consequences. Climate change measurements since 1955 at a major neutral mountain site in Hawaii, Mauna Loa, show a consistent rise in CO₂. Only now the readings have to be checked to see if they are biased by increasing coal burning in China. Dirty Coal generates 63% of China’s energy, and it thickens the air for miles.

China’s government officially recorded over 60,000 environmental demonstrations in 2006, and 70,000 the following year. Water and air pollution are the worst of any urban area on the planet, and it is largely due to their attempt to drive their economic engine. China may well become the leader of the industrial world, at the time when the rest of the world’s population stops tolerating even much lower levels of pollution than China is willing to accept.

Further China is notorious for their single party political domination and repression. Attempts by the party to bring the positive image to the world stage with the Olympics are already creating tension with Tibet, and many other parts of the country have their own problems with the central government. China is close to a million mutinies, and there is great potential for anti-government demonstrations during the Olympics.

China needs to discover that global leadership is not defined by arrogance, hubris, repression, poor quality control or pollution. Until China transcends its monolithic, all-powerful but perpetually behind the times Communist Party, and explores a grassroots, bottom up kind of democratic representative structure, it is living in antiquated chaos that other countries will fear, but not respect, let alone emulate.

**PART II: SPOTLIGHT ON THE FUTURE**

**HUMAN NATURE AND ENABLING CONSTRAINTS**

We are approaching a time when the established rules of the western culture’s economic order are falling apart. How do we get through a time of increasing social disorder – and how can we come out of this a safer, sustainable viable community?

A vast majority of the people alive today carry a mental model of how the world works by weaving together various combinations of the basic tenets of established religious, economic and political traditions. Most of us live in a crowded urban world of many people, scarce resources, daily conflicts, limited time and too many options. While it is nice to think of the challenges as wonderful, too often they are frustrating and sometimes downright depressing. Over the years, religious leaders and great social thinkers have developed different philosophies to cope with the dilemmas of human struggle. Each of us brings together our own unique combination of these traditions. Without trying to slight the depths of these various bodies of reflected human experience, here is a crystallization of the major ideas that bring us to what we think of as society:
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Hindu: God is in all things
Buddha: the universe is infinite
Confucius: there is a need for social order
Jewish: each individual has a relationship with a higher power, and with other people
Jesus: see and love God in your daily life to find heaven in this life
Catholic: society has a relationship with God
Islam: be devout, pray to God daily, fast during Ramadan, give to the poor, at least once go on a pilgrimage to Mecca
Luther: each of us has the choice for good or evil, and many challenges to act each day
Calvin: rewards for your labors
Hobbes: society needs to control powerful individuals
Locke: society cannot work without a social contract
Adam Smith: division of labor is more efficient
Jefferson: least government is best government
Elizabeth Cady Stanton: a woman must be independent before she can be free
Malthus: uncontrolled population growth leads to scarcity, war, famine and disease
Lincoln: a country should maintain unity and reconstruction driven by reconciliation
Darwin: adaptation is the key to species survival
Marx: each according to their ability, each according to their need
Keynes: government has a role to play in stimulating the economy
Justice William O Douglas: leave a place better than you find it
Maslow: food & shelter, safety, love, productivity and creativity are basic human needs
Kennedy: ask not what your country can do for you, ask what you can do for your country
Galbraith: what the private sector does poorly should be done well by the public sector
Ernesto Che Guevara: at the risk of sounding ridiculous, let me say that the true revolutionary is guided by feelings of love.

While most people try to do the right thing most of the time, every community has some established limits, some method of enforcing them, and some mechanism for punishing those who fail to live within the constraints. The purpose of this analysis is to offer a foundation for an examination of what role society, the government and our formal economic institutions can address in the future. What role should government play?

Short answer as a challenge to be addressed by the rest of this analysis: create a new ethic, based on the idea of plenitude instead of greed, and live within the finite limits of a healthy planet.

WOMEN HOLD UP HALF THE SKY

We need to create a climate of consciousness that demands minimum standards for human rights around the world. Assume every person has a right to health care and survival. That alone would eliminate half the crime in the world. Stand up to cultures that inhibit women’s rights and ability to speak out and provide for themselves, as some claim is the tradition of Mormons, Muslims, Catholics and too many husbands. As Herman Daly and John Cobb point out in *For the Common Good*, “efforts to reduce the
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excess of births over deaths should be on unwanted babies of mothers of any age. In earlier times when more children were an asset to the community as a whole, a woman had an obligation to have children, and on the whole, more rather than fewer of them. All the great religions arose during that period, and their teachings are deeply affected by social need. Today, however, a different basic attitude is required. Having a child is a privilege rather than a duty. The community may not have to deny that privilege to any couple who truly desires to exercise it. But, those who choose not to deserve the respect and appreciation of all. They should be aided and morally encouraged to act on their choice and not be caught in the trap of an unwanted pregnancy.”

POST INDUSTRIAL SUSTAINABLE FARMING

Michael Pollan, author of The Omnivore’s Dilemma, and In Defense of Food, came to the agricultural campus of the University of California, Davis to talk about a sustainable farm, where soil is added, not deleted:

“Just to summarize this farm: It is a polyculture, as the name suggests. He has a hundred acres of grass, and he grows beef, pork, broilers, eggs, turkeys, rabbits, and he has six species. They grow in this very intricate symbiotic system. Every animal is contributing some eco-system service to another. A hundred acres of grass, 400 acres of wood lots. Very hilly land. Not very good for row crops, but very good for grass. One of the first questions I asked Joel, What kind of farmer are you? Are you a rancher, a chicken farmer, are you an egg farmer? He said, No, I am a grass farmer.

“That is very striking to me. We don’t eat grass. There is no market in grass; there is a little market in hay. How can you be a grass farmer? He explained to me that is the basis of this ecosystem he has created. He is modeling these relationships on nature, the relationships of animals in nature. Just to give you one example, and there are several of these. They are all kind of wonderful. The relation of his beef and his chickens, his laying hens. He does grass fed beef, and he has a herd, seventy five animals or so. They spend one day in a paddock and they graze it really completely, when you put that many animals in a quarter acre, they graze it all down completely. Then at the end of the day he moves them to another paddock. What allows this to happen is this very light, cheap electronic fencing, which I think is the most important sustainable agriculture technology for animals agriculture. I could carry a quarter acre paddock on my shoulder and set it up myself in ten minutes, it is really remarkable stuff. They would graze down that pasture, and then we would build another one right next to it. He would then open the door…

“You hear about moving the cattle, and you need dogs, and chewing tobacco, a lot of trucks and a lot of screaming, and it wasn’t like that at all. They knew the drill. They did it every day. He was less like a cowboy than a Maitre d’, he kind of opened the door, and the cattle would move from one to another. They were so happy to get the next pasture because there was all that fresh green grass and the end of the day is when it is sweetest because it has been collecting sugar all day and that wonderful contented sound of cows ripping the grass and ruminating. It was a great end of the day scene.
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“Then he has his chickens. He waits three days. He calls it his hen mobile, and it looks like a ramshackle prairie schooner, he has made it himself, it is not an elegant piece of technology. He lowers the gangplank, and three hundred laying hens come streaming down the gangplank, and they fan out over the pasture. They go right for the cow paddies. And what they want to do is eat the larva, the maggots out of the cow paddies, and the reason he has waited three days is to grow those maggots as big and as juicy as he can, but if he waited any longer, they would hatch and he would have flies everywhere.

“By understanding the life cycle of this parasite, he is able to grow the important protein source for his chickens. They eat all of the flies, they take care of his fly problem. He calls the hens his sanitation crew. And they do these other things, in the process of digging out these larva, they spread the manure. They fertilize the paddocks with the very rich nitrogen manure themselves, and then he knows exactly how long they can be there before the nitrogen load is too high, and then he moves them to the next paddock. Six weeks later he has this flush grass in a blaze of growth, and he can either cut it for hay or he can bring in the cows again. It is a really exciting relationship because it is based on the relationship of birds and ruminants in nature. Birds are always following ruminants and cleaning up after them.

“To really appreciate it, we have to bear down, and remember I said he is a grass farmer, and look at the grass plant itself. Just think about one of those grass plants in one of those paddocks. What is happening is when a grass plant is sheered by a ruminant, it does something very interesting. It wants to keep its root mass in rough balance with its leaf mass. It is called the root shoot ratio. So what it does is it sheds roots, to balance out, and when it sheds the roots, it kind of cauterizes them and they die, then they are set upon by all the life living in the soil, the earthworms, the protozoa, the bacteria, the viruses, the fungi. And they digest those roots.

“And when they are done digesting it, that is soil, that is compost. That is how soil is built, it is built from the bottom up. That is how the great top soil of the prairies that pulsing of the pasture. He is actually creating soil. What does that mean? What that means is that at the end of the year, I will tell you how much he takes off this land: 40,000 pounds of beef, 30,000 pounds of pork, 10,00 broilers, 12,000 turkeys, 1,000 rabbits, 35,000 dozen eggs, off of this hundred acres. At the end of the year, there is more biodiversity, not less, more fertility, not less. More soil, not less. The significance of that is: This is not a zero sum system. In our heads all of us are stuck in this idea, that for us to get what we want from nature, nature must be diminished. It is a process of subtraction. He is suggesting it need not be that way, a sustainable, a truly sustainable system can actually improve the soil, improve biodiversity, leave the land better than before we removed our food from it”. (Mondavi Center, University of California, Davis 11/29/06)

Pollan talked about other things as well, some of which have been published in his new book, In Defense of Food: An Eater’s Manifesto. His rules are: Eat Real Food, Not Too Much, Mostly Plants. It provides a contrast with his picture of Polyface Farm and all its meat. Most people could have a “victory” garden, and take control of their own food, and
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share with their neighbors. Growing vegetables is easier than raising livestock. Just keep in mind the idea of replenishing the soil with nutrients and body, and paying attention to what the soil and your plants are trying to tell you.

BUILDING SUSTAINABLE COMMUNITY

Community. The area you frequent. More than a neighborhood, less than a nation, a state or even a city. Cities try to have an identity, a reputation, things they are known for. Cities have a sense of community, but this is a focus on community in a practical, every day, how can we make the system work, reality way.

Cities are wonderful, even magical, as Lewis Mumford wrote in 1938, in The Culture of Cities, “The city, as one finds it in history, is the point of maximum concentration for the power and culture of a community… a conscious work of art, and it holds within its communal framework many simpler and more personal forms of art. Mind takes form in the city; and in turn, urban forms condition mind… With language itself, it remains man’s greatest work of art. The nature of the city is not to be found simply in its economic base; the city is primarily a social emergent. The mark of the city is its purposive social complexity.” And from Mumford’s The City in History (1961), “the chief function of the city is to convert power into form, energy into culture, dead matter into the living symbols of art, biological reproduction into social creativity. The positive functions of the city cannot be performed without creating new institutional arrangements, capable of coping with the vast energies modern man now commands: arrangements just as bold as those that originally transformed the overgrown village and its stronghold into the nucleated, highly organized city”.

The problem with cities is that they are simply too big to administer face-to-face, where the regulator knows and lives with the people who are affected by the effects of their semi-regal bureaucratic actions, and interpretations of policy.

The term Economics originally meant “managing the household” but it was also a state of mind for the ruling government. John Kenneth Galbraith put it in the perspective of “the essentially social character of the metropolis. In its days of greatest elegance, the city was a household, and extension of the domestic arrangements of the ruler. No line then separated private from public tasks. Construction, artistic embellishments and maintenance of the city – what would now be regarded as public tasks – may well have absorbed the larger share of the aggregate public and private income. With the Industrial City it came to be assumed that the payment for public tasks – education, police protection, courts, sanitation, recreation, public entertainment, care of the old and impoverished – would be only a small subtraction from the total revenue. The private household, no one doubted, had the major claim.

“This continues to be the assumption. The consequences all recognize. Among the affluent and even among the poor, services supplied out of private income are far more
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amply endowed than those provided by the city. Houses are clean, streets are filthy. Television sets are omnipresent; schools are deficient.

“Where capitalism is efficient, it adds to the public tasks of the city; it increases the number of automobiles that must be accommodated in and through the city, adds to the detritus that must be picked up from the streets and makes progressively more difficult the problem of keeping breathable the air and sustaining a minimum tranquility of life.

“This is another way of saying that the social aspect of modern metropolitan life is extremely expensive, far more expensive than we have yet imagined.”

This is a discussion about a shift from the Industrial City, to an Ecological City, where there is an expected net ecological benefit from urban human living, rather than the ecological disaster that cities have become. The first thing to do is create some definable terms, beginning with community, which is being defined as a population of around 10,000 people.

For discussion and analysis, ballpark population definitions are: family: 10; neighborhood: 100; village: 1,000; community: 10,000; district: 100,000; region: 1 million. So Los Angeles would still be megalopolis with 8 million people, but it would become 7 to 9 regions for administrative purposes, which would allow consistency in communication, in ways that are currently impossible with the city/county built-in conflicts.

The problem is counties. They are out of date and obsolete. Ancient European and U.S. history is to blame for too much of our bureaucracy. By 1865, a majority of the country’s population was living in cities of more than 5,000 people. Clearly, the action moved from counties to the cities more than a century ago. Yet many of the U.S.’s domestic political problems now are the consequences of rural money dictating social, economic and tax policy for urban society. Just like Japan.

Counties are designed for land-focused rural government, not social policy such as courts, health and social services. Most domestic government since the New Deal has been to try to set up special districts to compensate for the limits of rural-oriented counties. The state should refocus around cities, which would allow the elimination of most of California’s special districts and half of the state bureaucracy.

Majority support today for continuing the tax cut reform of 1978 known as Proposition 13 in California is a reflection of a serious problem with government, but just saying no to the money will not improve governance. Bureaucratic confusion and miscommunication are the problem, and cleaner lines of communication are necessary to improve the situation.

Thomas Jefferson actually proposed dividing counties into wards of five or six square miles and to impart to these wards those portions of self-government for which they are best qualified, by confiding to them the care of their poor, their roads, police, elections,
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the nominations of jurors, administration of justice in small cases, elementary exercises of militia. These wards are pure and elementary republics, the aim of all of which together composes the State, and will make of the whole a true democracy as to the business of the wards, which is that nearest and daily concern.

Within this community-sized focus, individuals can mobilize and have a greater impact. Asking how can we improve the quality of life in cities (how can we make them healthier) can become the identified challenge of local groups and governments.

First off, the United States needs to recognize that energy consumption and waste generation are out of control, three times Europe’s, even though there is a comparable standard of living. The difference is what Richard Register refers to as “access by proximity.” Because most European cities were laid out before the automobile required an additional 70% space for its roads and parking, cities are much more compact, so they require less energy and resources to maintain.

The problem is the automobile. The world has exceeded the peak oil point, the midpoint in our potential use of petroleum on the planet. It is a finite resource, and eventually we will have used up most of it. That is any where from twenty to a hundred years away, but perhaps even in our lifetimes, depending on how rapidly we continue to accelerate our use of it to drive cars.

Ivan Illich wrote in *Energy & Equity* in 1978 that “the exchange value of time is reflected in language: time is spent, saved, invested, wasted and employed. As societies put price tags on time, equity correlates inversely with vehicular speed. The order of magnitude of the top speed which is permitted within a transportation system determines the slice of its time budget that an entire society spends on traffic. The automobile, the accelerating individual capsule enables society to engage in a ritual of progressively paralyzing speed.

“The model American annually puts in 1,600 hours including work time to pay for the car and gas, as well as insurance and taxes to get 7,500 miles: less than five miles per hour. In countries deprived of a transportation industry, people manage to do the same, walking wherever they go, and they allocate only three to eight percent of their society’s time budget to traffic instead of the 28 percent Americans sacrifice. What distinguishes the traffic in rich countries from the traffic in poor countries is not more mileage per hour of lifetime for the majority, but more hours of compulsory consumption of high doses of energy, packaged and unequally distributed by the transportation industry.

“Self-Powered Mobility: Bicycles are not only thermodynamically efficient, they are also cheap. With his much lower salary, the Chinese acquires his durable bicycle in a fraction of the working hours an American devotes to the purchase of his obsolescent car. The cost of public utilities needed to facilitate bicycle traffic versus the price of an infrastructure tailored to high speeds is proportionately even less than the price differential of the vehicles used in the two systems. In the bicycle system, engineered roads are necessary only at certain points of dense traffic, and people who live far from the surfaced path are not thereby automatically isolated as they would be if they
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depended on cars or trains. The bicycle has extended man’s radius without shunting him onto roads he cannot walk. Where he cannot ride his bike he can usually push it.”

Cities could be designed to work ecologically. According to Richard Register in his book, Ecocities: Building Cities in Balance with Nature (2002), “The quality of life depends largely on how we build our cities. Given that cities are so large, damaging and yet potentially beneficial, you’d think we would have long ago devised the science, study, discipline and art of ecologically-healthy city building. The higher the density and diversity of a city, the less dependent on motorized transport, and the less resources it requires, the less the impact it has on nature”.

The idea of Ecocities recognizes all these dilemmas and opportunities and the new realities of the twenty-first century, from rising atmospheric carbon dioxide, shrinking water tables, loss of agricultural land to sprawl – and energy wasting dead end of the automobile/highway/fossil-fueled industrial complex. Yet there are signs of the transition to sustainable communities and cities, which we must make if we humans are to survive; so our goal is: cities that can actually build soil, cultivate biodiversity, restore lands and waters, and make a net gain for the ecological health of the Earth.

Hazel Henderson points out that we humans have spent 98% of our collective history together as gatherer-hunters in roving bands. Yet we now comprise a six billion-person human family, living largely in huge mega-cities like Sao Paolo, Mexico City, Shanghai and Tokyo, with very little experience of managing our affairs at such a scale. We are consuming some 40% of the entire planet’s primary biomass production. This is accelerating the rate of extinction of our fellow species on which we are dependent, as we have migrated to the ends of the Earth.

According to Henderson, we have overshot the optimum in cars, suburbs, sprawl and its attendant patterns of energy waste, pollution and environmental destruction. We have overshot the mark in losing community and identity among thousands of acres of huge tract homes in former family farms – with even more demand for more roads, concrete, parking lots and strip malls.

Henderson thinks the economy can be graphically represented by a “cake chart,” a take-off on the pie charts economists use tirelessly to express percentages of this and that. The top layer of the cake is the “private” sector: production, employment, consumption, investment, savings. The next layer is the “public” sector: infrastructure, schools, municipal government and various services. The third layer down is the underground economy including tax dodges, black market exchange, and the like. Beneath these three “monetized” layers, in which cash is used as a means of valuation and exchange, is the non-monetized layer, based on bartering, home-based production, “sweat equity,” and what she calls the “love economy” of volunteerism: working to support family and friends with vegetables, cleaning, baby sitting, medical advice, and so on. In turn, this base layer of the human economy rests on the bottom layer of the cake, nature’s economy: the natural “resource base,” which not only ultimately provide everything basic to the human need for sustenance, but also serves to clean up our messes if we don’t get
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too far out of hand. To which Register adds: Given the order, with the human edifice built upon the natural one, it is clear that if our rules differ markedly from nature’s we are likely to run into problems.

Back to Register: Cities are by far the largest creations of humanity. Designing, building and operating them have the greatest destructive impact on nature of any human activity. As we construct them today, cities also do little for social justice, not to mention for the grace and subtlety of human intercourse. Yet our built communities, from village and town to city and megalopolis, also shelter and launch many of our most creative collaborations and cultural adventures and artifacts. As we build automobile/sprawl/infrastructures, we create a radically different social and ecological reality than if we build closely-knit communities for pedestrians. Contrast American sprawl with European traditional cities.

A study called The Cost of Sprawl was undertaken by three U.S. agencies – The Council on Environmental Quality, Housing and Urban Development, and the Environmental Protection Agency – and released in the spring of 1974.

The study compared low-, medium-, and high-density communities, and measured their impact on schools, fire and police services, governmental facilities, roads and utilities. It demonstrated that higher-density communities required 50 percent less land and 45 percent less investment cost in infrastructure (buildings, roads, landscaping and utilities), caused 45 percent less air pollution and a similarly reduced amount of water pollution runoff, and used 14 to 44 percent less energy and 35 percent less water. Costs of fire, police and other governmental services were similarly reduced in the higher-density community.

The high-density model was a mix far from the extremes of Manhattan, Hong Kong, or Paris. It included two- to six-story buildings and nothing taller. It left out the cost of the automobile entirely and it did not mention the savings from using transit in higher-density areas.

As we build so shall we live. The city, town or village – this arrangement of buildings, streets, vehicles and planned landscapes that serves as home – organizes our resources and technologies, and shapes our forms of expression. It is the key to the future healthy evolution of our species and will determine the fate of countless other species as well. The city, in fact, is the cornerstone of the civilization that currently embraces the entire planet. Insofar as our civilization has gone awry, especially in regard to its impact on the environment, a very large share of the problem can be traced to its physical foundations. Considering the crisis state of life systems on Earth – the collapse of whole habitats and the increasing rates of extinction of species – it follows then that cities need to be radically reshaped. Cities need to be rebuilt from their roots in the soil, from their concrete and steel foundations on up. They need to be reorganized and rebuilt upon ecological principles.
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Recent trends have not been encouraging: In 1960 one-third of the citizens of the U.S. lived in cities, one-third in suburbs, and one-third in rural locations. By 1990 well over half lived in suburbs. Between 1970 and 1990 the population of California increased approximately 40 percent while the land area of cities and suburbs went up 100 percent.

By 1992, after a new wave of suburbanization, the U.S. was getting approximately 60 percent of its oil from the Middle East. The better the gas mileage, the more the suburbs sprawl out over vast landscapes, the more demand there is for cars and freeways, and the more cars are needed to service the expanding suburbia. Ultimately and ironically, the more gasoline is needed. Thus the energy-efficient car helps create the energy-inefficient city. The car is part of a whole system of complex, necessarily interconnecting parts existing in an interdependent relationship with the total environment it helps create. Now that we have spent about half of the planet’s full endowment of petroleum resources, time to rely on petroleum is running out.

The bigger picture is far from encouraging. China started closing Beijing’s streets to bicycles to make way for cars in 1998, and it is currently engaged in a massive highway-building program. It plans enormous shifts of population from rural areas and farming to cities and manufacturing and business, and shifts from rail, bicycle and pedestrian cities to cities for motor vehicles on rubber tires – a colossal transformation in the wrong direction. The arrow is in the direction of increasing problems for the Chinese: according to UC Davis China expert Don Gibbs, China uses seven times as much energy as Japan per unit of production, 3.5 times as much as the U.S., and they are designing an exclusively auto based transportation system with highways and little public transit.

As Ivan Illich says: “The automobile has created more distances than it has bridged,” and once created, rendered bridging those distances without the automobile virtually impossible. Thus we have become structurally addicted to cars. The structure of the city, even whole national transportation systems, have become thoroughly dependent upon them”.

Register then quotes Jeff Kenworthy and Peter Newman, who studied thirty-two cities around the world and concluded: “Traffic engineers still claim freeways are better for fuel emissions, but the results of our study do not. Economically, they also appear to have failed. Our data show that, instead of people in cities with freeways saving time, and hence being more productive, they just spend more time in their cars. Freeways space cities out and hence overall travel is increased. Those cities which do not go for freeways but instead build up transit and bicycle access have gained economically and environmentally … Some short-term pain will be experienced as businesses and developers adjust their plans to a more transit-oriented city, but experience shows that the transition is worthwhile.”

Ecocity takes the idea of urban life in a new direction. The truths from which the ecocity idea emerges are based on the human body – its size, speed and requirements for nourishment, shelter, procreative and creative excitement and fulfillment – and on the relations of living organisms to each other and their environment.
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The density, diversity, form and function of cities, and the awareness of their citizens in this regard, are now key factors in evolution. On the positive side, the very form of the city, by providing access to culture, resources and nature, has the potential to raise consciousness of evolution to new heights. Though the effects on biology and evolution of today’s enormous sprawled cities are grim, learning about such cities and about the alternatives to them gives us the tools to solve many urban and evolution-sized problems.

Register’s favorite idea is “access by proximity,” that the easiest way to cut transportation costs is shorten the distance. He really sees the solution as growing structures up that leave some room for other things besides work.

Register is advocating that we build tall compact buildings, and allow open space around them. The size of the center is the horizontal multiplied by the vertical, and so a four-story height limit, though more dense than one or two, still forces horizontal development out several times over relative to a cluster of, say, ten- to twenty-story buildings, and eliminates the kind of civic focus that can produce grand plazas, parks, settings for sculptures and other special features. The vertical dimension can multiply the center’s size several times without affecting whatever horizontal distance is being considered. Tall centers are thus far richer culturally and economically than low rise ones.

In fact, given that building materials and construction techniques are easily able to support much taller building and that tens of millions of people are living or working at the fifth story or higher already and appreciating its benefits, it is nothing less than perverse for architects and theorists to refuse to explore the possibilities. Some of the most beautiful buildings on Earth are taller than four stories. Elevated gardens, art and public spaces on rooftops, terracing that could take rooftops up four stories at a step, bridges and rooftop streets that could make a real adventure of the third dimension – almost none of these are seeing serious experimentation.

The traditional village structure is one of the most profound inventions in history, and it applies to cities as well as villages. In ecocity transformations there is a direction, scale and form seen here: toward the centers, and smaller and taller.

The challenge of Ecocities is to find community in harmony with nature. For that, we need up to date information.

The biggest change of the last decade is the advancement of the Internet which has made communication and information sharing instantaneous. The technical work requires creating an information grid to manage individual/community/city data, to protect privacy while at the same time allowing public and economic decision making to improve the local community.

From the individual’s point of view, the computer information model needs to accommodate individuals’ lives to their convenience, and basically include what is called the Consumer’s Economic Space:
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Current computer technology would allow the consolidation of the information flows so that any community could maintain its information base if there is local political will. The existing city political structure creates two computer programs, called City Data and City Future. Within them, they build the ground rules for how the local area creates its own future.

The next social science challenge is to identify how to improve quality, described on a personal level by Thomas Michael Power in The Economic Pursuit of Quality (1988), “Even in the commercial sector of the economy, what we really purchase is quality, not quantity. Beyond a rather low level of income we do not spend our money mainly for pounds or calories of food, but for taste, nourishment, and variety. Our clothing budget is not spent on homogeneous body covering, but for qualitatively distinctive and stylish clothes. Many important qualities are supplied outside the commercial economy, such as clean air, scenic beauty, safety and a sense of community. It is the sum of commercial and noncommercial qualities that accounts for total economic welfare. These qualities are not independent of physical dimensions, but neither can they be reduced to physical dimensions alone. Economic development is the increase in the sum of marketed and nonmarketed qualities available to individuals in the local community”.

Empirically, define local sustainability by means of quantifiable limits and safe minimum standards; establish an optimum scale that takes into account the physical carrying capacity of a defined area, then focus on developing statistics that measure welfare.

A local area should be evaluated in three areas: quality of life, cost of living and standard of living. Together, these three commonly recognizable terms add up towards what Stafford Beer calls eudemonia, or well-being. They are a first draft at creating a quantifiable measure of “optimal community.” Quality of life includes air and water quality, longterm health indicators, and intangibles of the natural environment. Cost of living focuses on a market basket index of basic goods. Standard of living includes measures of percent self-sufficiency, as well as the upper strata for the more high stepping. Communities can compare their statistics with other areas, and gradually come up with standards, by decentralized agreement. People looking for a new place to live will compare different communities’ statistics. Long time residents will understand their own community’s unique idiosyncrasies. And people will try to improve their numbers.

Most people care about their community, and take pride in it. It is the major long term investment of their lives. It would be nice to have an economic language that encourages community action that makes efficient use of scarce resources and is ecological.

For a hands on manual for creating good politics around issues in your local community, Economic Renewal Guide: Collaborative Process for Sustainable Community Development, by Michael J. Kinsley, Rocky Mountain Institute, 1997
TRANSFORMATION TO ECOTOPIA

In 1975, Ernest Callenbach published a book called *Ecotopia*, about an ecologically-responsible society: “a few Ecotopian militants spread the point of view that economic disaster was not identical with survival disaster for persons – and that, in particular, a financial panic could be turned to advantage if the new nation could be organized to devote its real resources of personal energy, knowledge, skills, and materials to the basic necessities of survival. If that were done, even a catastrophic decline in the GDP (which was, in their opinion, largely composed of wasteful activity anyway) might prove politically useful.

“What was at stake, informed Ecotopians insist, was nothing less than the revision of the Protestant work ethic upon which America had been built. The consequences were plainly severe. In economic terms, there was a drop in the Gross Domestic Product by more than a third. But the profoundest implications of the decreased work week were philosophical and ecological: mankind, the Ecotopians assumed, was not meant for production, as the 19th and 20th centuries believed. Instead, humans were meant to take their modest place in the seamless, stable-state web of living organisms, disturbing that web as little as possible. This would mean sacrifice of present consumption, but it would ensure future survival – which became an almost religious objective, perhaps akin to earlier doctrines of “salvation.” People were to be happy not to the extent they dominated their fellow creatures on the earth, but to the extent they lived in balance with them. As a basic philosophy, the idea of political power is to put technology and social structure at the service of humankind, rather than the other way around.

“The Ecotopian economy must be considered a mixed one, but some elements of the mix are novel, and because of ecological and political considerations the balance of the mix is quite different. During the economic transition, people realized that a new era was indeed upon them and began spontaneously taking over farms, factories and stores. This process was chaotic, but it was not anarchic; it was controlled by the local governments and local courts. Such take-overs set the tone for the ongoing tasks of production and distribution of essentials; and they worked. But more massive and deliberate economic changes soon took place, above all in the diversion of money and manpower toward the construction of stable-state systems in agriculture and sewage practices, and in the scientific and technical deployment of a new plastics industry based upon natural-source, biodegradable plastics. (The public transportation system, which remains an infringement on the stable-state principle, also consumed many resources.)

“The new tax system relies entirely on a corporation tax – that is, a tax upon production enterprises (including individuals). It is based partly on net income, but also partly upon “turnover,” or gross income. Like most functions of governing, tax-levying is carried out by the communities (mainly cities), which delegate very limited powers to the regional and national levels. The reasoning behind this system is complex, but it turns upon the view that all taxes are fundamentally a means of the government seizing a share of
Evolving to Sustainability

economic output and putting it to publicly determined purposes – and that this seizure should therefore be at the immediate source, simple, understandable, just, and open to public view. (Ecotopian tax returns are not confidential.)

“This tax policy includes laws that redefine the position of the employee. The workers in an Ecotopian enterprise must now all be “partners”: a person cannot just set up a business, offer wages to employees, fire them when they are no longer needed, and pocket the profits. There is no personal income, sales, or property taxes in Ecotopia. Aside from personal articles, no Ecotopian can inherit any property at all. There is a land tax that encourages concentration and probably accounts for the remarkable compactness of Ecotopian cities. There is a widespread aversion to other types of tax on the grounds that they are either regressive or promote divisiveness among people – whereas the enterprise tax, bearing as it does on collective groups, is thought to promote solidarity, and competition between work groups.

“There is no super-rich class in Ecotopia. Certain occupational groups, such as artists, scientists and some doctors, have slightly higher incomes, though national training policies deliberately seek to keep such differentials moderate. But there are said to be no individuals in Ecotopia who grow personally rich because they control the means of production and hire other people’s labor power.

“Direct absentee investment by one enterprise or person in another enterprise is not permitted. Surpluses can thus only be “invested” by lending them to the national banking system, which in turn lends funds to enterprises. This gives the bank tremendous leverage on the economy; it appears to contradict many Ecotopian protestations of decentralization, even if the national bank does maintain regional branches that have great autonomy.

“Ecotopian enterprises generally behave much like capitalist enterprises: they compete with each other, and seek to increase sales and maximize profits, although they are hampered by a variety of ecological regulations. The fact that the members of an enterprise actually own it jointly (each with one vote) puts certain inherent limits on what these enterprises do. For instance, they do not tend to expand endlessly, since the practical maximum size of joint-ownership firms seems to be less than 300 people – beyond that they tend to break down into bureaucratic, inflexible forms and lose both their profitability and their members, who seek more congenial environments. Also, the enterprises seem to be just as concerned with conditions of work as they are with profits, and in many instances members seem willing to accept lower profit and wage levels in exchange for a comfortable place to work or a way of organizing work which offers better relations among people doing it.

“The tax revenues are used by the community governments to support their recycling services, housing, power, water, telephone, medical services, police, courts and so on. Education is financed as a free-market private enterprise. A pro rata share of tax funds goes to the regional and national governments, to support operation of larger-scale
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systems such as the trains, defense, telecommunications, and most of the research establishment.

“Despite the importance Ecotopians attach to agriculture and other rural affairs, the Ecotopian constitution is city-based and not rural-based. The Ecotopian main cities dominate their regions through a strict application of one-person-one-vote principles. Furthermore, the county level of government is omitted entirely.

“There is a surprisingly small national welfare system, considering that Ecotopians enjoy a lifetime “guarantee” of minimal levels of food, housing, and medical care. While some citizens, especially those working on untried developments in the arts, utilize this guarantee to exist without jobs, most people either feel the guarantee level is too abject to exist on, or find it’s desirable to work in order to provide themselves with a lively social life. The old and disabled, of course, must survive by taking advantage of the guarantee; and, while low, is perhaps slightly higher than the U.S. Social Security system (which does not have the health, housing and food benefits of Ecotopia.)

“The Ecotopian government established long-range economic policies of diversification and decentralization of production in each city and region. Laws were introduced that flatly prohibited many types of highly polluting manufacturing and processing operations. Since tens of thousands of employees were put out of work, the new government made two responses to this. One was to absorb the unemployed in construction of a train network and of the sewage and other recycling facilities necessary to establish stable-state life systems. The other move was to adopt 20 hours as the basic work week – which, in effect doubled the number of jobs but virtually halved individual income. (There were, for several years, rigid price controls on all basic foods and other absolute necessities.)

“Ecotopians spout statistics on social costs with reckless abandon, calculations that inevitably involve a certain amount of optimistic guesswork. Ecotopians claim their system is considerably cheaper, if all the costs are added – and not ignored, or passed on through subterfuge to posterity or the general public. Acknowledging all the costs is necessary in order to achieve the stable-state life systems that are the fundamental ecological and political goal. If, for instance, the practice of “free” disposal of wastes in watercourses was continued, sooner or later somebody else would have to calculate – and bear – the costs of the resulting dead rivers and lakes. There is a relentless tendency to fix responsibility on producers.

“Ecotopian plastics are entirely derived from living biological sources (plants) rather than from fossilized ones (petroleum and coal). Originally there were two major objects for the researchers. One was to produce the plastics, at low cost and in a wide range of types: light, heavy, rigid, flexible, clear, opaque, and so on – and to produce them with a technology that was not itself a pollutant. The other objective was to make them all biodegradable, that is, susceptible to decay. This meant that they could be returned to the fields as fertilizer, which would nourish new crops, which in turn could be made into new
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plastics – and so on indefinitely, in what the Ecotopians call, with almost religious fervor, another steady-state system”.

CONCLUSION: RESPECTING INDIGENOUS POPULATIONS

The ultimate law of human ecology is: Nature bats last. No matter how smart or powerful humans are, we must live within the real constraints of nature.

This means that decision taking should be driven down to the lowest level, that people who will have to live with the consequences of an action should be the ones who are the final authorities. If the people of Valdez, Alaska had the choice, every one of them would have said that all oil tankers should be double-hulled, with electronic detectors to notify the ship’s captain if the outer hull had been violated, so that action could be taken before the inner hull is punctured and oil spilled. Single hull oil tankers are an example of a false economy that is prevalent in corporate industrial decision taking.

Western Civilization has spent the past five centuries imposing itself on the rest of the planet, and the results are not pretty. Most indigenous cultures know a lot about how to respect their native environment, and most industrial corporations do not. The theme of Jared Diamond’s book, Collapse: How Societies Choose to Fail or Succeed is that if a culture destroys its forests it will destroy itself. Industrial corporations are destroying most of the forests on the planet.

There is open debate about what is meant by the term “survival of the fittest”, especially by those species endangered by human action. Nature doesn’t care whether the human species survives or not, and unless our species turns its back on the automobile based economic system, the species may not survive to see the 22nd Century.

We need to create a healthy future. The planet needs fewer people, and we all should take responsibility for the planet’s health as well as our own and our community’s. We need a system that works.

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Jon Li writes about healthy social systems.
Jon is usually seen around Davis riding his bicycle to a meeting.
THE HARD FACTS OF SOFT SOCIAL SYSTEMS: A GENERAL SYSTEMS EXPLANATORY MODEL FOR SCHOOLS AND WORKPLACES

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ABSTRACT

In this paper, a new model for social systems is introduced, one that aims to inform all decision makers in schools and workplaces. The need for such a model is great, given the failure of modern well-intentioned reform efforts and wide variety of decision-makers. The new model is gleaned out of Boulding’s nine-level typology of system complexity, and named TPO for the three key domains that are clarified: technical, personal and organizational, for specialists; and things, people, and outcomes, for non-specialist decision-makers. These three key parts of a social system have very different properties. First, things (technical) are of three kinds--level 1: frameworks (e.g., buildings, books and equipment); level 2: clockworks (e.g., school routines, schedules and calendars); and level 3: thermostat-like systems (e.g., school goals which people--students and educators--self-regulate to attain.) Things are predictable and designable. Second, people (personal) in a social system are not designable. While things like thermostats self-regulate to externally prescribed criteria, living systems self-regulate to internally prescribed criteria (level 4: open; e.g., a living cell). Living systems (levels 4-7) act to meet their own basic needs first, then, in people, higher needs—generally predictable by Maslow’s hierarchy of human needs: survival, safety, belonging, achievement, self-actualization and transcendence. People’s behavior decreases in predictability due to inherent individual differences (level 5: blueprint; e.g., plant); differing immediate perceptions from among competing stimuli (level 6: image-aware; e.g., animal), and their own long term reflections, prior knowledge, choices, and abilities (level 7: symbol processing; e.g., human). The third part of a social system is labeled outcomes (organizational). Outcomes depend on people’s behavior. If people easily meet their basic needs, they will act to meet the organization’s needs. This principle is not a question of ethics, but a question of physics. It is natural, biological, and scientific law that people will behave to meet their individual and personal needs (level 7: human) before their social system or organization’s needs (levels 8 and 9). Level 8 systems (social) are optional. Level 7 functioning is mandatory. A person can transfer schools (level 8), but cannot transfer bodies (level 7). The TPO model of a social system clarifies that effective designers put all their attention to things, the designable components of a social system: frameworks; clockworks; and thermostat-like systems (e.g., school and classroom goals and ratios and flows of resources). Effective designers fashion these designable components as attractors, to allow system members to meet individual/ personal goals as first priority, and organization goals as second priority. Goals of the TPO approach are termed here systemic renewal, or systemic change efforts designed to increase opportunities for each social system member to meet his/her own self-perceived goals at his/her own pace. The ISSS Morning RoundTable corresponds to the goals of systemic renewal and the TPO model.

Keywords: General systems theory; social system theory; systemic school renewal
The Hard Facts of Soft Social Systems

BACKGROUND

The Failure of Social System and School Reform Efforts

In spite of advancing technology and equity in today’s schools and workplaces, serious problems are resulting in social systems decline. Today, through research and study in schools as complex systems, I have come to better understand this decline in schools as a predictable reaction to decades of constant short-lived ill-conceived piecemeal reform efforts. This aggravated decline affects students, teachers, everyone. It is reported in the descriptive educational literature as increasing participant isolation and disconnection (Erickson, 1989; Maeroff, 1988), urban school staff struggling for survival (Rogers, 1989); and increasing school-site violence (Walker, 1995). I illustrate the decline in schools using Maslow’s hierarchy in Figure 1. The black line represents the original and intended participant goals and outcomes of schools as achievement, self-actualization, and transcendence and the current and observed goals as safety and survival.

<table>
<thead>
<tr>
<th>Intended or original</th>
<th>Observed or current</th>
</tr>
</thead>
<tbody>
<tr>
<td>6- transcendence</td>
<td>6</td>
</tr>
<tr>
<td>5- self-actualization</td>
<td>5</td>
</tr>
<tr>
<td>4- achievement</td>
<td>4</td>
</tr>
<tr>
<td>3- relationship</td>
<td>3</td>
</tr>
<tr>
<td>2- safety</td>
<td>2</td>
</tr>
<tr>
<td>1- survival</td>
<td>1</td>
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</tbody>
</table>

Figure 1. Intended vs. Observed Outcomes of Modern Schools and Society

Taking a wider perspective, Gardner (1991) explains that the deficiencies in our schools reflect deficiencies in our wider society (illustrated in Figure 1 by the gray line). Bracey (1992), too, argues that the “true crisis of education in America is that it is trying to function not only in an era of disinformation but also in a time of social decline that looks like collapse” (p. 104). This era of disinformation and social decline arguably has a worldwide scope, evidenced in the terrorist bombings in New York and Washington, D. C., on September 11, 2001 (Thomas, 2001), and the current wars and brutality in so many parts of the world. Most shockingly, these negative outcomes are being aggravated by educated societies who believe they are doing the right thing. It is clear that current educational and social systems are in need of a systemic renewal, and that our “best” reform efforts are based on erroneous assumptions.

In fact, it was helpful to me to realize that traditional scientific thinking might explain that 9 (quality of school) plus 1 (a new reform effort) would equal 10 (improved quality of school). In reality, my experience predicts that 9 + 1 = 8; or 9 (quality of school programs) plus 1 (new ill-conceived reform effort) equals 8 (reduced quality in schools).
The Hard Facts of Soft Social Systems

The Complexity and Variety of Decision-Makers

In addition to ill-conceived change efforts, there are many different school decision makers, with different viewpoints. In addition to their different perspectives, school decision makers often do not understand each other. Frequently, the specialized vocabulary within each group of decision makers is confusing to another group. For example, the meanings of the terms TOP DOWN and BOTTOM UP have opposite meanings in management and reading theory. In management theory, TOP DOWN (the old paradigm) means the CEO makes key decisions, and BOTTOM UP (the emerging new paradigm) means the front line workers are involved in key decisions (Column 1 and 2 in Table 1).

In reading theory, BOTTOM UP (the old paradigm) assumes that the children learn to read by memorizing letters, sounds, then words. TOP DOWN assumes that children learn best and first by reading and listening to engaging stories (Column 3 in Table 1). Confusingly, Top Down and Bottom Up have opposite meanings in management and reading theory.

<table>
<thead>
<tr>
<th>PARADIGM</th>
<th>MANAGEMENT THEORY</th>
<th>INSTRUCTION THEORY: READING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Paradigm (out of favor)</td>
<td>top down- the CEO (T) makes key decisions</td>
<td>bottom up- children (SS) learn letters and sounds (K) first, then words, sentences, paragraphs.</td>
</tr>
<tr>
<td>New Paradigm? (in favor)</td>
<td>bottom up- the front line workers (SS) are involved in key decisions</td>
<td>top down- children learn reading (K) by listening to and reading engaging stories first.</td>
</tr>
</tbody>
</table>

School decision makers at the school site include teachers, principals, parents, students, and other administrative and clerical staff. There are school decision makers at the district office, publishers of school textbooks, at the universities and other teacher training institutes, and at the state and federal government. Checkland explains that the most objective view is one that sweeps in the views of all the stakeholders (Jackson, 1992, p. 139). School decision makers have different and often conflicting perspectives in the positions that they hold without the complication of using different vocabulary. I illustrate these problems in Figure 2 as if they were speaking different languages while trying to build an educational system, and how much this resembles the Tower of Babel.
The Need and Audience

With all this complexity, there is a need for a scientific paradigm that explains behavior in social systems. Decision-makers need to better understand classrooms and meetings in schools, workplaces, communities, and so forth. The explanatory model needs to be repeatable, verifiable, and credible to all school and social system decision makers: teachers, principals, superintendents, parents, students, theoreticians, researchers, lawmakers; CEOs, managers, employees; presidents, kings, citizens, and so forth.

THE METHOD: BOULDING’S 9-LEVEL TYPOLOGY

Boulding’s 9-Level Typology of System Complexity is an eye-opening foundation for a model that explains how schools and social systems really work. The model is developed with the aim of making sense to all decision makers, from the most sophisticated to the most novice. The model is outlined below. Passages that follow explain the components.
The Hard Facts of Soft Social Systems

Kenneth Boulding, one of the founders of general systems theory, looked to the real world and nature to uncover the hard facts of soft social systems. He ranked the systems of the world in a nine level taxonomy. From simple to complex, his nine levels are:

1- FRAMEWORKS: systems composed of static structures, such as the arrangements of atoms in a crystal or the anatomy of an animal.

2- CLOCKWORKS: simple dynamic systems with predetermined motions, such as the clock and the solar system.

3- “THERMOSTATS:” cybernetic systems capable of self-regulation in terms of some externally prescribed target or criterion, such as a thermostat.

4- OPEN-SYSTEMS: systems capable of self-maintenance based on a throughput of resources from its environment, such as a living cell.

5- BLUE-PRINTED GROWTH SYSTEMS: systems that demonstrate divisions of labor, that reproduce not by duplication but by the production of seeds or eggs containing preprogrammed instructions for development, such as the acorn-oak system or the egg-chicken system.

6- INTERNAL-IMAGE SYSTEMS: systems capable of a detailed awareness of the environment through sense organs (eyes, ears, etc.). Information is received and organized into an image or knowledge structure of the environment as a whole, a level at which animals function. At this level the image or perception intervenes between the stimulus and response.

7- SYMBOL-PROCESSING SYSTEMS: systems that use language and other symbols, are self-conscious, and can contemplate the past, present, and future. Humans function at this level. Level 7 systems, humans, also walk upright and have hands and opposable thumbs.

8- SOCIAL SYSTEMS: multicephalous systems comprising actors functioning at level 7 who share a common social order and culture. Social organizations operate at this level.

9- TRANSCENDENTAL SYSTEMS: systems composed of the "absolutes and the inescapable unknowables." (adapted from Boulding, 1956)

Boulding’s Model Linked to Organization Theory and the Social Sciences

Boulding’s typology is clarifying to social science/organization theory (illustrated in Figure 3). Boulding notes that “most of the theoretical schemes of the social sciences are still at level 2 [clockworks], just now rising to level 3 [thermostat systems], although the subject matter clearly involves level 8 [social systems] (Scott, 1992, p. 78).”
Boulding further explains that each higher level systems contains subsystems of all those below it (Figure 4). For example, a social system (level 8) is made up of systems and subsystems of level 7, 6, 5, 4, 3, 2, and 1. A human (level 7) is made up of systems and subsystems of level 6, 5, 4, 3, 2, and 1. To illustrate both Boulding’s 9 system types and the nature and increasing complexity of the nine types. I look at Figure 3 as a top view of Boulding’s nine system types. Figure 4 is a front view and shows all the subsystems contained in each system type.
The Hard Facts of Soft Social Systems

thermostat-like systems) are self-regulating to externally prescribed or designable. These three levels are the domains of traditional science.

In Figures 3 and 4, Levels 4 - 7 are clear boxes, as living systems are undesignable by an outside designer. They are self-regulating to internally prescribed criteria (their own needs and goals). These levels, the arenas of Miller’s Living Systems (1978), are beyond the scope of traditional scientific law.

Levels 8 - 9, are clear boxes with dotted-line boundaries, as social systems are unbounded and intangible. In contrast, levels 1 - 7 systems have fixed boundaries. Thus, level 8 systems (social) are optional. Level 7 functioning is mandatory. A person can transfer schools, workplaces, etc. (level 8), but cannot transfer bodies (level 7).

Boulding’s Model to Unify the Two Main Camps: Directive vs. Participatory

Boulding’s typology clarifies the two main camps of school approaches and theory—directive vs. participatory. It also solves the issues in the conflicting “either-or” perspectives of organization theory. Boulding’s typology uncovers both the problems of, and the value of, the top-down governing bureaucratic assumptions.

The problems of clockwork assumptions of old paradigm models. The fundamental flaw of current old paradigm directive or bureaucratic models lies in the assumption of predictability and stability or “clockwork” assumptions. For example, it assumes that the principal controls the teachers and the teacher controls the students. The directive model does not distinguish between processes that Boulding calls clockwork (predictable) and nonclockwork (variable, intangible). Our current educational reform efforts are based on, or maintain traces of, these unexamined assumptions. For example, in the new paradigm term “cooperative learning,” “cooperative” means operating jointly, but the more common meaning of cooperative is obedient (an old paradigm virtue).

The value of clockwork assumptions. While the clockwork assumptions underlying bureaucratic systems are known to be inadequate, Boulding remarks that “much valuable information and insights can be obtained by applying low-level systems [frameworks, clockworks] to high-level subject matter [humans, social, and transcendental systems]” (Scott, 1992, p. 78). The reason for this is that each of Boulding’s system levels incorporates all those below it.

Thus, proponents of the new paradigm (e.g., decentralization and self-regulation) who ignore the need for framework and clockwork subsystems are also short-sighted. The fully-specified new paradigm must subsume characteristics of the old; it must be joint-optimizing for both stability and flexibility. More specifically, Boulding’s model distinguishes between subsystems of external and internal agency to explain what can be predicted or externally designed and controlled, and what is controlled by internal agency or criteria (i.e., individual human choices).
Boulding’s explanation of the problems (inadequacies) and value (suitabilities) of the top-down governing model was clarifying and unifying to me. The old question for organizational change theorists and practitioners was: “Which is correct? top-down/directive or laissez-faire/participatory?” There are the two main camps, but, of course, many theorists and practitioners (especially systems theorists) know that both directive and participatory components are needed. Boulding’s model transcends the old question and clarifies the new question: “Which parts of an organization need top-down control, and which parts need bottom-up flexibility?”

**THE TPO MODEL: THINGS, PEOPLE AND OUTCOMES**

Figure 5 is an illustration of my journey to the TPO model. In 1980, I began my journey as a classroom teacher turned detective when I saw a “Warning: Teacher Burnout!” poster in the teachers’ workroom. I determined that $9 + 1 = 8$ in most educational reform efforts, and I wondered why. What were the laws behind these predictable outcomes?

In 1992, I found my answers in Boulding’s nine systems and system levels. His model explained that people in schools and organizations behave according to their own needs, abilities, perceptions, and choices (levels 4-7). In 1997, I published my elaboration of Boulding’s model (Gabriele, 1997) illustrating his distinctions between components.

In 2007, I joined a local writing group. At each session, I wrote or rewrote a section of my article intending it for a popular audience. At this time, I discovered a good, simple way to categorize the three key parts: things, people, outcomes (Right in Figure 5).

Things, people, and outcomes are the three key parts of a social system because they each have very different properties. They each behave according to different laws and principles. Understanding the characteristics of each of these key parts, and designing around this understanding, is the value of the TPO model.
Things

Things of a school can be predicted, designed, regulated to exteriorly prescribed criteria/goals—in other words—the agent is an architect, builder, publisher, superintendent, principal, teacher, and others. In the TPO model, three kinds of things are:

(1)-**Frameworks or static structures** (e.g., buildings, rooms, chalkboards, bookshelves, wall charts, equipment, TVs, computers, books, supplies, paper, pencils, pens, etc.)

(2)-**Clockwork procedures and systems** are composed of frameworks plus clockworks (calendars, schedules, classroom and school opening & closing routines and procedures—hourly, daily, weekly, monthly, yearly and holiday or other special times). Some examples of clockwork procedures follow. That is, systems are ON or OFF by clockwork. The school year is in session (ON) September though June; School is OFF July and August. School is in session from 8-3. Faculty meetings are Tuesday from 3-4:00. Period One is from 8-8:55 every day. In Period One, students have a review activity from 8-8:10. The teacher introduces a new lesson from 8:10 to 8:30. Students work on activities coming out of the lesson in small groups or teams from 8:30 to 8:55. Tests are Friday.

(3)-**Control Systems or Thermostat-like procedures, processes, or systems** (composed of frameworks, clockworks and thermostat-like systems) are self-regulating to exteriorly prescribed criteria/goals. The thermostat pictured in Figure 6 illustrates the parts and functions of a control system.

First, there are the parts that are designable and controllable.

- **The Goal.** The system’s goal is set by an outside agent. In this case, the teacher has set the desired room temperature at 68 degrees.

- **The System Modes.** The teacher can choose among various system modes: the gray circles along the bottom of the thermostat.
  - **OFF:** The system is OFF and does not respond to the 68 degrees set by the teacher
  - **ON: manual:** The system is ON but does not respond to the goal set by the teacher. The room gets hotter and hotter, if the windows and doors are closed.

![Figure 6. A Thermostat and Its Settings](image_url)

Second, there are the parts that are self-regulating to exteriorly prescribed criteria.
**ON: automatic.** The system self-regulates to outside information, the selected goal. In Figure 6, the larger white triangle on top is a goal set by the teacher/manager: 68 degrees. The smaller black triangle is reflecting that the temperature of the room is about 67 degrees. The heater has turned itself turned off and will stay off until the temperature falls below the range (perhaps 65 degrees). When the heater turns on again, it will stay on until the room is 70 degrees, and then it will turn off again.

**The Sensor.** The black triangle in Figure 6 represents the sensor. The teacher has no control of this. It was designed by the engineer to sense (in this case) room temperature.

Things, and the three kinds of things--frameworks or static structures; clockworks; and thermostat-like processes or systems-- are pictured in Figure 7A as the first of the three parts of a social system.
The Hard Facts of Soft Social Systems

People

People in a school are not designable by an outside agent (teacher, principal, etc.). They are (level 4) self-regulating to interiorly prescribed criteria/goals. Their behavior is generally predictable as acting to meet their own individual goals/needs: for survival, safety, belonging, achievement, self-actualization and transcendence (Maslow in Valle, 1989). Predictability decreases because of human differences: (level 5) genetic diversity; (level 6) people’s immediate here-and-now perceptions through the five senses from among competing stimuli; and; (level 7) their long-term perceptions, reflections, and choices (contemplating the past, present, and future). Thus, the variety in people’s behavior is almost limitless. People, as the second of the three key parts of a social system, are pictured in Figure 7B.

Of course, people also are composed of frameworks, clockworks and thermostat levels. Because of their level 1-3 systems (e.g., their bodies, organs, circulatory and respiratory systems), their behavior is generally predictable; they will act to meet their own self-perceived needs and goals. The thermostat (level 3) is a key function in higher-level systems. For example, relating only to Maslow’s hierarchy of needs, people have six thermostats that are self-regulating: for survival, safety, relationship, achievement, self-actualization, and transcendence. When the more basic needs are not being met (survival, safety, relationship) people have to use their energy to meet them and they have little energy for higher goals (achievement, self-actualization, and transcendence).

Outcomes

Outcomes are the third key part of a social system. Three types of outcomes for social systems are illustrated in Figure 7C: Social systems are transcending, average, or declining. These three types are oversimplified, but they provide new insights into social system behavior, desired and undesired outcomes, and what should count as evidence.

Transcending. Figure 7C left indicates transcending. People in the organization or school are getting their needs and goals met so easily that there is considerable evidence of social and transcendental function. The organization is carefully designed so that all of its members can meet their needs and goals at their own rates. People meet their own goals and transcend them to new goals.

Average. Figure 7C center indicates average. People in the organization or school are getting some of their needs and goals met so that there is some evidence of social function.

Declining. Figure 7C right indicates declining. Most people in the organization or school are not getting their individual needs and goals met, so there is little evidence of social function. People at the bottom of the hierarchy are in the survival mode. People at the top of the hierarchy are working towards level 7 personal goals (wealth, promotions), rather than level 8 organization goals.
A close up of these three general types of outcomes is in Figure 8. As stated above, these three types are an oversimplification. On one hand, instead of three types, this way of looking at schools or social systems might yield a continuum with schools ranging from transcending to declining (two headed arrow in Figure 8). Moreover, outcomes in social systems are very complex and multifaceted. Some people (students, teachers, parents or others) may be very satisfied and transcending and others at the survival level. People’s satisfaction also varies from year to year, day to day, from hour to hour. Even given this complexity, these three types of outcomes inspired by Boulding are a useful and illuminating way to look at school outcomes. For a long time now, schools have been reported as functioning at the survival level in the descriptive educational literature. It is helpful to understand that many people in struggling schools, in the survival mode, downshift from level 8 (school goals) to level 7 (personal goals.)
The Hard Facts of Soft Social Systems

The TPO Model For Everyone

I created Figure 9 for all school decision makers with the idea that a picture is worth a thousand words. It is an illustration of the TPO theory—things, people, and outcomes—as the three key parts of schools. The behavior of things (T) is designable, predictable, and/or controllable. The behavior of people (P) is not controllable. We can predict that people will behave according to their own goals, perceptions and abilities. Outcomes (O) depend on people’s behavior and are even less predictable. What is predictable about outcomes is the following: If social systems are designed or function in ways that satisfy their members, outcomes will be positive and the social system will flourish. On the other hand, if social systems are designed or function in ways that ignore the needs of their members, outcomes will be negative and the social system will deteriorate.

Since I wrote the article, in 1997, I have often made presentations at educational conferences. I showed my TPO powerpoint presentation to a friend of mine, a retired teacher. At first, she said that “things” was too general of a term. As I continued and elaborated Boulding’s concepts, she changed her mind. We talked about it and thought that I should not begin my presentation with the TPO model. Things seem too simple. I decided NOT to name this book TPO or things, people and outcomes. I am hoping, by now, readers are ready for these categories: things, people and outcomes. I am hoping that readers realize that these terms are not too simple, but elegant! I am defining elegant from wikipedia as “being unusually effective and simple.”

The TPO Model For Specialists and Theorists

Education Theory. With regard to education theory, I thought it was interesting and significant that McREL (McREL.org), a well respected nonprofit educational organization, categorizes the three major facets of schools in a similar way (2008). Their domains are the Technical, Personal and Organizational, an organizer chosen from work by educational scholars Cordell and Waters (1993). Their TPO approaches differ from the TPO model in this book in that they focus on the designable components of these three domains. Whereas, my use of the terms focuses on the different behavioral laws and principles of the three domains.
The Hard Facts of Soft Social Systems

Organizational Change Theory. With regard to organizational change theory, the three-part TPO model (technical goals, personal goals and organization goals) builds on and enhances organizational change theory: socio-technical theory, and critical systems theory.

- **Critical Systems Theory.** A key contribution of Critical Systems Theory is that it acknowledges that decision-makers’ viewpoints are not simply plural, they are sometimes coercive and conflicting. However, risks of critical systems practice are that focusing on the imbalance in power of the stakeholders increases polarity. The TPO model avoids this issue by showing how to distribute resources, rather than illuminating the unequal distribution of resources.

- **Socio-technical theory.** Socio-technical theory, in brief, recognizes the interaction between people and technology in workplaces. The TPO model has added a new valuable distinction. The “Socio” in socio-technical theory is now clarified by TPO to consist of two parts: personal and organizational goals. This is an important distinction because personal and organizational goals have very different appeals and behaviors (which is the heart of this book).

Table 2 provides another picture, summarizing and comparing three models. Top left is the name of the approach or model, top right are the parts of the model. Row 1 is the workplace model, Socio-Technical Systems. Row 2 is the educational model referred to in McREL. Row three is the model in this book, the TPO model for everyone.

**Table 2. Comparing Three Models**

<table>
<thead>
<tr>
<th>The Model</th>
<th>Parts of Each Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Socio-Technical</td>
<td>technical</td>
</tr>
<tr>
<td>2- TPO – for specialists</td>
<td>technical, personal</td>
</tr>
<tr>
<td>3- TPO for everyone</td>
<td>things, people, outcomes</td>
</tr>
</tbody>
</table>

**IMPLICATIONS OF THE TPO MODEL**

The major finding for hard facts and hard theory is this: *The principle, individual needs before organization needs, is not a question of ethics: It is a question of physics.* This is not a soft, new-age idea, it is a hard fact.

In other words, it is natural, biological, and scientific law that people will behave to meet their individual and personal needs (level 7: human) before their social system or organization’s needs (levels 8). Level 8 systems (social) are optional. Level 7 functioning is mandatory: a person can transfer workplaces (level 8), but cannot transfer bodies (level 7).

Therefore, effective educators and school designers put all their attention to things, the designable components of a social system: frameworks, clockworks, and thermostat-like
The Hard Facts of Soft Social Systems

systems (e.g., workplace goals and ratios and flows of resources). Effective designers fashion these designable components as attractors, to attract people in the system. Things are selected, arranged, distributed to maximize peoples access to them. People in the systems will use them at their own rates, for their own self-determined purposes. The These things/attractors function to allow students, parents and staff to meet individual/personal goals as first priority, and organization goals as second priority. As people meet their basic needs with a minimum of energy, they have energy to meet their organization’s needs which result in desired outcomes. Goals of the TPO approach are termed here systemic renewal, or systemic change efforts designed to increase opportunities for each social system member to meet his/her own self-perceived goals at his/her own pace. The ISSS Morning RoundTable corresponds to the goals of systemic renewal and the TPO model.

REFERENCES

Preservation of Misperceptions – Stability Analysis of Hypergames

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ABSTRACT

The present paper tries to model how some kinds of misperceptions of agents are preserved in a decision making situation where multiple agents are involved. We use hypergame model which is a theoretical framework to deal with agents who may misperceive situations (Bennett et al., 1979). After each play of hypergame, agents may update their perceptions based on the result, that is, the structure of the hypergame may change. However, in some case, they may not, and the hypergame is ‘stable’, that is, their misperceptions are preserved. To discuss stability of hypergames, we newly define a solution concept what we call stable hyper Nash equilibrium. Using these ideas, we analyze the stability. To demonstrate change in perceptions of agents, we consider agent-based intrinsic motivation. Although we provide general foundation for discussion, we analyze a game called battle of sexes as an example case.

Keywords: hypergame theory, misperception, stable hyper Nash equilibrium, intrinsic motivation, battle of sexes.

1. Introduction

Hypergame theory is a theoretical framework to deal with agents who may misperceive a decision making situation (Bennett et al., 1979). In a hypergame situation, agents are assumed to perceive the situation subjectively, and the subjectivity may cause their misperceptions.

Hypergame theory was proposed to address a strict assumption of classical game theory, which generally requires complete information. It has been assumed in game theory that all agents fully understand the situation and thereby they all see the same game. The assumption has restricted the possibility of analysis of real world situation because imperfect knowledge or different perception affects decision making quite often. This perceptual problem has been pointed out in several ways since early time in the development of game theory. One of the most notable achievements is analysis in games with incomplete information by Harsanyi (1967). He provided a mathematical framework of games including subjective probability distributions by ‘Bayesian’ players. Although Bayesian games and hypergame theory share common philosophy in some aspects, we believe that suitable model for analysis depends on the situation.
Preservation of Misperceptions – Stability Analysis of Hypergames

In the present research in the framework of hypergame theory, we will conduct stability analysis of dynamically changing games. After agents play a hypergame, they may encounter outcomes that they have never expected because of their misperceptions. In those cases, intrinsic motivations to improve their own perceptions would arise from the surprises. These agent-based motivations may lead to learning of situations or communications among the agents and to changes of their perceptions, that is, agent-based motivation may bring about structural change of the hypergame. This process would never occur in classical game situations.

However, even if there exist misperceptions, some types of hypergames may remain unchanged and be stable in the sense that misperceptions of agents are preserved. Our main concern is with preservation of misperceptions, which has not been discussed rigorously so far, though Kaneko and Kline (2002) argue this problem epistemologically based on game theoretical analysis.

Our main purpose of the present paper is to formalize such stability of structure of hypergames and to give reasonable explanations to the stability from a viewpoint of agent-based intrinsic motivations for improving perceptions.

2. Hypergame Model and Its Solution Concepts

In this section, we introduce some formal definitions of models and concepts as a preparation for our study.

Before that, we will introduce an intuitive idea of noncooperative game and explain about our research motivation more clearly by using a well-known model.

Noncooperative game is a game which describes a decision making situation where the agents just seek their own payoff without communication. One of such typical models is the following “Battle of sexes”. The story of this game is as follows:

A boy and a girl, say i and j respectively, are going to have a date. Now, they have to decide where to go. Their options are to go to see a boxing game (B) and music concert (M). They, however, have to make a decision independently under some reason. The boy prefers boxing, while the girl prefers music concert. However they both prefer having a date together to going out by oneself.

The situation can be formulated in terms of matrix shown by Fig. 2.1, where the formal definitions will be given later.

<table>
<thead>
<tr>
<th>(i\backslash j)</th>
<th>(B)</th>
<th>(M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(B)</td>
<td>2, 1</td>
<td>0, 0</td>
</tr>
<tr>
<td>(M)</td>
<td>0, 0</td>
<td>1, 2</td>
</tr>
</tbody>
</table>
2.1 Noncooperative Game and Nash Equilibrium

Since the idea of hypergames are derived from game theory, especially from noncooperative game theory, we begin with formulating the game model and its central solution concept, Nash equilibrium.

A decision making situation in which multiple agents are involved and compete each other for their own utility can be formally modeled in terms of noncooperative game as definition 2.1.

Definition 2.1 (noncooperative games)
A noncooperative game is given by $(N, S, u)$, where:

- $N = \{1, \ldots, n\}$ is a set of agents.
- $S = \times_{i \in N} S_i$ is a set of strategies, where $S_i$ is a set of strategies of agent $i$. We call $s \in S$ an outcome.
- $u = (u_i)_{i \in N}$ is a profile of utility functions, where $u_i : S \to R$ is agent $i$'s utility function.

Let $x, y \in S$, suppose $u_i(x) > u_i(y)$ iff agent $i$ prefers outcome $x$ to $y$, and $u_i(x) = u_i(y)$ iff agent $i$ is indifferent between $x$ and $y$.

The classical noncooperative games assume that every agent has common knowledge about the structure of the game, which means it supposes every agent knows all the components of the game as shown in definition 2.1 completely.

Nash equilibrium is a most well-known solution concept for noncooperative games and hypergame solutions concepts we use in our study are based on its idea. A Nash equilibrium is such an outcome of the game that every agent has no incentive to deviate from it as long as the others do not change their strategies.

Definition 2.2 (Nash equilibrium)
$s^* = (s_i^*, s_{-i}^*) \in S$ is a Nash equilibrium of a noncooperative game $G = (N, S, u)$ iff

$\forall i \in N, \forall s_i \in S_i, u_i(s_i^*, s_{-i}^*) \geq u_i(s_i, s_{-i}^*)$. 

Preservation of Misperceptions – Stability Analysis of Hypergames

Fig. 2.1 Battle of sexes
The matrix implies that both two agents completely understand the opponent’s strategies and payoff. Although this is requirement of the classical game model, it is not always guaranteed in real world. For example, when it is not long since they got to know each other, they might not know about the opponent well. They might misunderstand the opponent’s preference. If they play the game under misperceptions, they might encounter unexpected outcome and have intrinsic motivation to improve their perception. Or they might not encounter unexpected outcome in spite of the misperceptions and not have such a kind of motivations. We discuss this problem formally through the paper.
In the above definition we call $s_i^*$ $i$'s Nash strategy. For a noncooperative game $G$, let us denote the set of Nash equilibria by $N(G)$, while the set of Nash strategies of agent $i$ by $N_i(G)$.

### 2.2 Hypergame Model

As mentioned in Introduction, hypergame theory provides a theoretical framework which contains critically different assumptions from those of noncooperative game theory with respect to perceptions of agents. Unlike in noncooperative game model, in a hypergame model, each agent is assumed to construct his/her ‘subjective game’ based on how he perceives the situation. Although hypergame theory has been examined in several ways (Inohara, 2002; Wang et al., 1988), we focus on the class of ‘simple hypergames’ because it provides the most basic but essential hypergame model.

**Definition 2.3 (simple hypergame)**

A simple hypergame $H$ is given by $(N, (G_i)_{i \in N})$, where:
- $N = \{1, \ldots, n\}$ is a set of agents involved in the situation
- $G_i = (N_i, S_i, u_i)$ is the subjective game of agent $i$, where:
  - $N_i$ is a set of agents perceived by agent $i$.
  - $S_i = \times_{j \in N} S_j^i$ is a set of strategies perceived by agent $i$, where $S_j^i$ is a set of strategies of agent $j$ perceived by agent $i$.
  - $u_i = (u_j^i)_{j \in N}$ is a profile of utility functions perceived by agent $i$, where $u_j^i : S_i \rightarrow R$ is agent $j$’s utility function perceived by agent $i$.

In a simple hypergame, it is assumed that each agent perceives the situation subjectively in a form of a complete information game (subjective game). Agents consider their own perceptions are common knowledge respectively, so that they plays based on different perceptions but no one knows this.

The whole game, the list of subjective games of all agents, is called a hypergame $H$, that is, $H = (G_1^i, \ldots, G_n^i)$, and nobody except ‘God’ can know $H$. Note that the superfix in Definition 2.3 indicates an agent who perceives the component. In the subsequent discussions, we use the word ‘hypergame’ in the sense of simple hypergame. Although we can consider mixed strategies in a similar way as classical game theory does (Sasaki et al., 2007), we deal only with pure strategies and ordinal utility in the present paper.

Next, we define such an ‘imaginary’ game that we would obtain by assuming that every misperception has been eliminated and every agent perceives his/her own components, strategies and payoff correctly. We call such a game a base game.

**Definition 2.4 (base game)**

$BG = (N, S, u)$ is a base game which is a noncooperative game generated from a hypergame $H = (N, (G_i)_{i \in N})$ satisfying the following conditions:
- $S_i = S_j^i$
- $u_j = u_j^i$
Preservation of Misperceptions – Stability Analysis of Hypergames

A base game is a noncooperative game where each agent’s strategy set and payoff are ones in his/her own subjective game in the hypergame. We should notice that base game is not well-defined as a noncooperative game if the agent cannot define his/her payoff on outcomes including the other’s strategy that he/she dose not recognize when there exist such strategies. In the subsequent analysis, we focus only on hypergames in which the agents may misperceive only the others’ payoff. We call this class of hypergames ‘perturbed hypergame’. We can always define base game from perturbed hypergame.

**Definition 2.5 (perturbed hypergame)**
A hypergame \( H = (N, (G_i')_{i \in N}) \) is called a perturbed hypergame of base game \( G = (N, S, u) \), iff we have \( \forall i, j \in N, N_i' = N, S_j' = S_j \).

In a perturbed hypergame, all agents correctly perceive the set of agents involved in the situation and every agent’s strategy set, while they may misperceive the other’s payoff.

### 2.3 Solution Concepts in Hypergames

We introduce two types of solution concepts of hypergames: hyper Nash equilibrium and stable hyper Nash equilibrium, where the latter is original of this paper.

**Definition 2.6 (hyper Nash equilibrium)**
\((s_{i*})_{i \in N} \in \times_{j \in N} S_j'\) is called a hyper Nash equilibrium of a hypergame \( H \) iff \( \forall i \in N, s_{i*} \in N(G_i') \).

Hyper Nash equilibrium is defined as a profile of such strategies that each agent plays according to his/her Nash strategy in his/her own subjective game (Kijima, 1996). Agent \( i \)'s strategy in hyper Nash equilibrium, \( s_{i*} \), is called \( i \)'s hyper Nash strategy. Let us denote the set of hyper Nash equilibria in hypergame \( H \) by \( HN(H) \). The following lemma is straightforward from the definition but useful for the calculation.

**Lemma 2.1 (set of hyper Nash equilibrium)**
In a hypergame \( H \), we have \( HN(H) = \times_{i \in N} N(G_i') \).

If we assume Nash strategies as decision making discipline of agents, rational outcomes of a hypergame are necessarily hyper Nash equilibrium, so that it is well-suited to predict the outcome of an one-shot hypergame. However, in a hyper Nash equilibrium, it may occur that strategies the others have chosen are different from what the agent expects. For example, let \( i, j \in N \) \( (i \neq j) \), then \( j \)'s hyper Nash strategy, \( s_{j*} \in N(G_j') \), might not be included in any Nash equilibria of \( i \)'s subjective game. In such cases, the structure of the hypergame would change, because agents would ‘learn’ something from the outcome. They may try to update their perceptions to have more ‘correct’ understanding or to communicate each other to resolve the misperceptions. Learning of situations is necessarily one of main interest in hypergame study (Takahashi et al., 1999). We cannot
find this nature of equilibrium in Nash equilibrium in noncooperative games, where expectations about equilibrium by agents are consistent with each other.

Now we introduce another solution concept, stable hyper Nash equilibrium, to treat changes of equilibria.

**Definition 2.7 (stable hyper Nash equilibrium)**

\[(s^i_*)_i \in N \times \bigtimes_{j \in N} S^j_i \] is called a stable hyper Nash equilibrium of a hypergame \( H \) iff

\[\forall k \in N, (s^i_*)_i \in N(G^k).\]

Stable Nash equilibrium is as such a profile of strategies that is Nash equilibrium in every subjective game. Let us denote the set of stable hyper Nash equilibria of a hypergame \( H \) by \( SHN(H) \). It is given by the intersection of the sets of Nash equilibria perceived by each agent in similar way as Lemma 2.1.

**Lemma 2.2 (set of stable hyper Nash equilibrium)**

In a hypergame \( H \), \( SHN(H) = \bigcap_{i \in N} N(G^i) \).

At stable hyper Nash equilibrium, strategies the others have chosen are necessarily consistent with an agent’s anticipation so that the agent has no incentive to update his/her perception or to communicate with other agents for resolving misperceptions. This solution concept not only can predict which outcome will occur in an one-shot hypergame similar to hyper Nash equilibrium. But, in contrast to hyper Nash equilibrium, stable hyper Nash equilibrium is once accomplished, it is also consistently ‘stable’ even when the situation is repeated, as long as there is no change in agents’ decision making discipline or perceptions about the game (We will discuss this issue in the next section).

**2.4 Example**

Using a hypergame shown below (Fig. 2.2) as an example, we illustrate the models and concepts introduced so far.

<table>
<thead>
<tr>
<th>i \ j</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4, 2</td>
<td>1, 3</td>
</tr>
<tr>
<td>B</td>
<td>3, 1</td>
<td>2, 4</td>
</tr>
</tbody>
</table>

\( G^i \): i's subjective game

<table>
<thead>
<tr>
<th>i \ j</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2, 4</td>
<td>3, 3</td>
</tr>
<tr>
<td>B</td>
<td>1, 1</td>
<td>4, 2</td>
</tr>
</tbody>
</table>

\( G^j \): j's subjective game

Fig. 2.2 Hypergame \( H \)
Preservation of Misperceptions – Stability Analysis of Hypergames

Let us consider a hypergame $H = (N, (G^i_{i \in N}))$, where $N = \{i, j\}$ and $G^i$ and $G^j$ are $i$'s and $j$'s subjective game, respectively. There $S^i_j = S^i_i = \{A, B\}$ and $S^j_i = S^j_j = \{X, Y\}$. Values in the matrix express their ordinal utility. By definition 2.4, the base game $BG$ is generated from $H$ as Fig. 2.3. It is the game which would be obtained if all misperceptions in $H$ disappear.

\[
\begin{array}{c|cc}
  i \backslash j & X & Y \\
  \hline
  A & 4, 4 & 1, 3 \\
  B & 3, 1 & 2, 2 \\
\end{array}
\]

Fig. 2.3 Base game $BG$

Equilibria in this hypergame are given as follows:

- $N(G^i) = \{(B, Y)\};$
- $N(G^j) = \{(A, X), (B, Y)\};$
- $HN(H) = N(G^i) \times N(G^j) = \{(B, X), (B, Y)\};$
- $SHN(H) = N(G^i) \cap N(G^j) = \{(B, Y)\};$
- $N(BG) = \{(A, X), (B, Y)\}.$

An outcome $(B, X)$ is a hyper Nash equilibrium but not a stable hyper Nash equilibrium, thus according to our definition, it is not stable, while the other outcome $(B, Y)$ is stable (see 2.3).

2.5 Relationships Among the Solution Concepts

In this section, we examine global relationships among the solution concepts.

First, we have the following proposition with respect to relationship between the two solution concepts in hypergames.

**Proposition 2.3 (relation between two equilibria in hypergames)**

In a hypergame $H$, we have $SHN(H) \subseteq HN(H)$.

**Proof:**

It is obvious from definition 2.6 and 2.7.

Proposition 2.3 says that if there exists a stable hyper Nash equilibrium, it is necessarily a hyper Nash equilibrium. In other words, stable hyper Nash equilibrium is more strict solution concept than hyper Nash equilibrium.
Next, we have the following theorem with respect to relationship between stable hyper Nash equilibrium and Nash equilibrium of the base game.

**Theorem 2.4 (stable hyper Nash equilibrium and Nash equilibrium of base game)**
For a given hypergame $H$, let $BG$ be base game which derives from $H$. Then we have $SHN(H) \subseteq N(BG)$.

**Proof:**
Let $(s_i^{j**})_{i\in N} = (s_1^{j**}, ..., s_n^{j**}) \in \times_{j\in N} S_j^i$ be a stable hyper Nash equilibrium.

By definition 2.7,

$\forall k \in N$, $(s_i^{j**})_{i\in N} \in N(G^k)$

$\Rightarrow \forall k \in N$, in $G^k$, $s_k^j \in S_k^j, u_k(s_k^{j**}, s_{-k}^{j**}) \geq u_k(s_k^j, s_{-k}^{j**})$

$\Rightarrow \forall k \in N$, in $BG$, $s_k \in S_k, u_k(s_k^{**}, s_{-k}^{**}) \geq u_k(s_k, s_{-k}^{**})$, where $s_k^{**} = s_k^{j**}$.

$\Leftrightarrow (s_i^{j**})_{i\in N} \in N(BG)$

On the other hand, $(s_i^{j**})_{i\in N} \in N(BG) \Rightarrow (s_i^{j**})_{i\in N} \in SHN(H)$ does not always hold.

---

Theorem 2.4 claims that if there exists a stable hyper Nash equilibrium, then it is necessarily a Nash equilibrium of the base game. It implies that an outcome which is not Nash equilibrium in the base game cannot be stable hyper Nash equilibrium in the hypergame.

Furthermore, we have the following theorem from these results.

**Theorem 2.5 (the nonexistence condition of stable hyper Nash equilibrium)**
For a given hypergame $H$, let $BG$ be base game which derives from $H$. If $HN(H) \cap N(BG) = \phi$, then $SHN(H) = \phi$.

**Proof:**
It is direct from proposition 2.3 and theorem 2.4.

---

Theorem 2.5 shows that when there exist hyper Nash equilibria in a hypergame, if all of them are not Nash equilibrium in the base game, there does not exist stable hyper Nash equilibrium. An intuitive interpretation of the theorem is that when we anticipate all of outcomes which seem to happen actually (hyper Nash equilibrium) would not happen if all the misperceptions are eliminated, those outcomes are necessary unstable.

Hence the relationships among the solution concepts in a hypergame $H$ can be depicted by Fig. 2.4. ‘All outcomes’ in the figure means $\times_{i\in N} S_i^j$. We can easily see that the results with respect to the example in 2.4 of course satisfy these relationships.
Preservation of Misperceptions – Stability Analysis of Hypergames

3. Stability Analysis in Battle of Sexes and Preservation of Misperceptions

In this section, by using battle of sexes game as an example, we will illustrate how the structure of hypergames may change and how, in some cases, misperceptions of agents may be preserved in the context introduced in the previous chapter.

3.1 Preparation for analysis

For preparing for our further analysis, we first categorize how the agents’ perceptions change into two types, A and B, as follows:

Change of type A is change independent of the agent’s intrinsic motivation, while Change of type B is change generated by the agent’s intrinsic motivation.

Change of type A may occur even if the agent does not seek it intentionally, while change of type B cannot occur unless he/she seeks it, that is, unless he/she has ‘intrinsic motivation’ to update his/her perception.

Whether an agent has such an intrinsic motivation or not depends on (a) if the outcome is as he/she expected or not and, if so, (b) if he/she accepts the outcome completely or not (Fig. 3.1). The former is simply related whether or not the outcome is Nash equilibrium in his/her perception. On the other hand, the latter is an ‘emotional’ issue of agents as will be argued later.
Preservation of Misperceptions – Stability Analysis of Hypergames

![Diagram]

**Fig. 3.1 Intrinsic motivation**

Change of agents’ perceptions is based on some information they can get. We restrict here such information only to that with respect to the opponent’s payoff.

Next, we categorize hypergame situations in two cases according to whether there exists stable hyper Nash equilibrium or not. We call these two types of hypergame situations ‘unstable hypergame’ and ‘stable hypergame’, respectively as follows:

**Definition 3.1 (stable and unstable hypergame)**

We say a hypergame $H$ unstable hypergame if we have $SHN(H) = \emptyset$, while we call a hypergame $H$ stable hypergame if we have $SHN(H) \neq \emptyset$.

In Fig. 3.1, if the answer to the question (a) is No, the situation is an unstable hypergame, while if it is Yes, the situation is a stable hypergame.

**3.2 Stability analysis of battle of sexes**

By using the ideas introduced so far, we conduct stability analysis, that is, we analyze in what situation, what type of hypergame is stable or unstable and explain why misperceptions may be preserved in some cases. Although here the analysis is conducted for case of battle of sexes between two agents, the discussion can be generalized.

First, when both the agents perceive the situation correctly and know the opponent’s information completely, we can express the situation of the battle of sexes as base game shown by Fig. 3.2. It is the same as $G = (N, S, u)$ of Fig. 2.1, where $N = \{i, j\}$, $S_i = S_j = \{B, M\}$, $u_i$ and $u_j$ are as in the matrix.
Preservation of Misperceptions – Stability Analysis of Hypergames

\[
\begin{array}{c|cc}
  i \setminus j & B & M \\
  \hline
  B & 2, 1 & 0, 0 \\
  M & 0, 0 & 1, 2 \\
\end{array}
\]

Fig. 3.2 $G$: Battle of sexes (base game)

The game has two Nash equilibria in the range of pure strategies, i.e. \( N(G) = \{(B,B),(M,M)\} \). Although to predict which of the results of the one-shot game will really happen has been a difficult coordination problem in game theory, it is out of our interest of the present paper. Instead we regard this game as a base game and analyze how and why the situation may or may not change, when first date is its perturbed hypergame.

Case 1: Unstable hypergame

Now suppose both the agents misunderstand the opponent’s preference each other as follows:

\begin{align*}
  i: & \text{ “}j\text{ is not interested in boxing at all.”} \\
  j: & \text{ “}i\text{ is not interested in music concert at all.”}
\end{align*}

Then the situation can be formulated in terms of hypergame model by Fig. 3.3. We set \( H = (G^i, G^j) \).

\[
\begin{array}{c|cc}
  i \setminus j & B & M \\
  \hline
  B & 2, 0 & 0, 1 \\
  M & 0, 0 & 1, 2 \\
\end{array}
\]

$G^i$: $i$'s subjective game

\[
\begin{array}{c|cc}
  i \setminus j & B & M \\
  \hline
  B & 2, 1 & 1, 0 \\
  M & 0, 0 & 0, 2 \\
\end{array}
\]

$G^j$: $j$'s subjective game

Fig. 3.3 Battle of sexes (unstable hypergame)

Since Nash equilibrium in each subjective game is given by \( N(G^i) = \{(M,M)\} \) and \( N(G^j) = \{(B,B)\} \), the unique hyper Nash equilibrium is \((M,B)\). However, there does not exist stable hyper Nash equilibrium in this hypergame. The fact is consistent with theorem 2.5.

When the agents play this hypergame, they both would encounter unexpected outcome. Then it necessarily leads to emergence of intrinsic motivation for improvement of perception in each agent as shown in Fig. 3.1. That is, change of type B would always
Preservation of Misperceptions – Stability Analysis of Hypergames

occur. For example, if it is possible to communicate each other directly, they may try to do so and to find out the opponent’s ‘real’ preference. Even if they cannot have such a direct communication, they would learn something from the result and update their perceptions. In this case, i expected that j would surely choose music concert, while she chooses boxing actually. Thus i would reconstruct his perception for the next date taking into account possibility of j’s preference for boxing.

Furthermore, we can also consider change of type A in agents’ perceptions in this case. For example, one of j’s friends may tell i that she prefers having a date to going to a music concert alone, and if he believes the information, he would update his perception about j’s payoff. This kind of communication occurs often independent of whether or not i seeks it, that is, independent of his intrinsic motivation.

All of such interactions or/and learning by agents may result in change of the structure of the hypergame, so that H may become another hypergame H' (≠ H) including different misperceptions from the previous play. If they could communicate each other thoroughly and reach mutual understanding, it may become a normal noncooperative game same as the base game which does not include misperceptions at all (Fig. 3.2). In some cases, agent i may get to perceive the possibility that agent j may misperceive how i perceives the situation. Then, the ‘hierarchy of perception’ emerges. This kind of hypergame is formulated as n-level hypergames (Wang et al., 1988). In other cases, an agent may get to take into account more than one possibility with respect to what is the ‘real’ situation. Then, the situation can be regarded as a kind of Bayesian game (Harsanyi, 1967). Anyway when they have second date (Play 2), they would play different situation from the first date (Play1) (See Fig. 3.4).

![Fig. 3.4 Change of battle of sexes (starting from unstable hyperegame)]

Case2: Stable hypergame

Next, suppose both the agents misunderstand the opponent’s preference each other as follows:

i: “j is happiest when she enjoy my hobby together.”;

j: “i is not interested in music concert at all.”
Preservation of Misperceptions – Stability Analysis of Hypergames

*i*’s perception is different from the previous case, while *j*’s perception is same. Then the situation can be formulated in terms of hypergame model as Fig. 3.5. We set \( H = (G^i, G^j) \).

<table>
<thead>
<tr>
<th>( i \backslash j )</th>
<th>( B )</th>
<th>( M )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( B )</td>
<td>2, 2</td>
<td>0, 0</td>
</tr>
<tr>
<td>( M )</td>
<td>0, 0</td>
<td>1, 1</td>
</tr>
</tbody>
</table>

\( G^j \): *i*’s subjective game

<table>
<thead>
<tr>
<th>( i \backslash j )</th>
<th>( B )</th>
<th>( M )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( B )</td>
<td>2, 1</td>
<td>1, 0</td>
</tr>
<tr>
<td>( M )</td>
<td>0, 0</td>
<td>0, 2</td>
</tr>
</tbody>
</table>

\( G^j \): *j*’s subjective game

**Fig. 3.5 Battle of sexes (stable hypergame)**

Since Nash equilibrium in each subjective game is \( N(G^i) = \{(B, B), (M, M)\} \) while \( N(G^j) = \{(B, B)\} \), this hypergame has two hyper Nash equilibria, \( (B, B) \) and \( (M, M) \). Therefore it can be predicted the result of this hypergame as either of these two outcomes. In contrast to Case 2, this hypergame has a stable hyper Nash equilibrium, which is \( (B, B) \). It is quite natural assumption that when there exist multiple Nash equilibria, any agents do not choose such a strategy that leads to Pareto dominated one. According to the assumption, *i* should choose *B*, and \( (B, B) \), stable hyper Nash equilibrium, is the unique predictable outcome.

In this case, the outcome is expected one for both. Thus intrinsic motivation for improvement of perception does not emerge in neither of the both agents directly from the outcome. This is a crucial difference from unstable hypergame.

However, even if the outcome is expected one for both, the motivation may emerge in an agent in some specific cases. It is because the agent cannot accept the outcome due to some reasons. Then a kind of ‘emotion’ like frustration arises, and it may provoke motivation to correct perception. This would lead to change in agents’ perceptions of type B. For example, *i* may possibly find out that *j* does not look so happy though he has expected \( (B, B) \) is the best for her as well and ask her why. Or, seeing *i* does not appreciate at all that *j* comes to the date sacrificing herself to enjoy her own hobby, *j* may become so stressful that she confesses her actual preference to *i*. These processes can change agents’ perceptions.

As similar to unstable hypergame, we can also consider the possibility of change of type A in this case. For example, one of *j*’s friends may tell *i* that she prefers music concert to boxing in fact. This information may come independent of his intrinsic motivation.
Preservation of Misperceptions – Stability Analysis of Hypergames

Considering all of such update of perceptions, possibility of change of the hypergame is similar with unstable hypergame (Refer to Fig. 3.4).

However, as stated above, agents have intrinsic motivation for improvement of perception only in some specific cases where they have emotions to do so, while they always have such motivation in unstable hypergame. Now let us consider the following two assumptions:

(i) There is no information coming to an agent unless he/she seeks it.
(ii) Both agents accept the outcome with no frustration.

Then, since neither of change in perceptions of type A nor B occurs, $H$ would be consistently stable. When they have the second date (Play 2), they would play the same hypergame and choose same strategies as the first date (Play 1). Likewise they will play the same in their third date (Play 3), and forever. In this way, the misperceptions of agents are preserved through all the dates (Fig. 3.6).

![Fig. 3.6 Repeated battle of sexes (stable hypergame)](image)

The two assumptions dose not influence on the changing process of unstable hypergame (Fig. 3.4) because agents always have intrinsic motivation for learning even under the assumptions.

Before closing this section, we would like to point out one thing regarding misperceptions based on our discussion so far. Misperception is often problematic. In the case of the example in section 2.4, elimination of all misperceptions leads to Pareto optimal equilibrium, $(A, X)$, while the current stable hyper Nash equilibrium, $(B, Y)$, is not Pareto optimal. To achieve this, for example, intervention by a third party is important. Otherwise agents may remain to stay at the not-better outcome for both.

However, misperception is not always problematic, either. Suppose the case of Fig. 3.6. The boy and girl, $i$ and $j$, may be happy and continue to be along with each other. On the other hand, if they know the opponent’s actual preference correctly, they may become to have trouble with each other to decide where they have a date.

4. Conclusions

We examined how perceptions of agents are changed and why some sorts of misperceptions are preserved in terms of hypergame model mainly using the game of battle of sexes as an example. We defined formally the hypergame model and introduced a new solution concept, stable hyper Nash equilibrium, which is essential for analyzing
the stability of hypergames. Then we clarified their entire relationship. Based on these theoretical foundations, we conducted intensive stability analysis. To argue change in perception of agents, we focused on agent-based intrinsic motivation.

To discuss more about the changing factors of perceptions we stated in section 3 like intrinsic motivation, emotion, communication and learning is one of our main future works.

REFERENCES


ABSTRACT

After-sales service is an important source of revenue and profit for OEM (Original Equipment Manufacturer) Telecom firms. A good performance of the after-sale service provides a competitive advantage for the OEM firm against their competitors in case of customer acquisition or even retention. However, the design and management of the after-sales service is a challenge for many reasons, e.g. obviously the OEM can’t produce services in advance of demand, the only thing they can do is just make predictions about product failure. In the other hand, the supply process is also a source of variability. The match demand and supply process is another challenge. In order to tackle and mitigate this kind of problems this paper shows how to build the system of the after-sales service supply chain going from strategic business plan, master production plan for spare parts and labor, safety levels of inventory in consignment to customer, etc. Also we emphasize the information technology and coordination that need to exist within the different echelons into the supply chain, so this can be viewed as a system which included the repair process, the delivery process and the collect process.

Keywords: Service Parts, Supply Chain, Production Systems.

INTRODUCTION

After-sales service represented a reasonable amount of revenue for telecom OEMs (Original Equipment Manufacturer)1 that offer spare parts management and repair to their customers. The consulting firm Accenture (Dennis & Kambil, 2003) mentioned in general that “after-sale parts and service are the new frontier of competitive differentiation and profit enhancement, offering nearly double the profit potential of first time product sales”. Similar evidence can be found in a previous study made by the Wharton School (Cohen et al 1999), which revealed that gross margins for after sales service in the computer industry in North America in 1998 generally exceed 50 percent for enterprise system2, and around 20 percent for non-enterprise systems3.

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1 Whenever we refer to OEM into this paper, we are talking about telecommunication OEMs e.g. Alcatel-Lucent, Ericsson, Cisco, etc. which would be considered the supplier.
2 Enterprise refers to high end products such as main frames, midrange systems, servers and data centers (see Cohen et al 1999)
3 Non-Enterprise refers to products such as PCs, desktop systems and peripherals (see Cohen et al 1999)
On the other side, in a customer perspective, mobile and wireline operators\(^4\) need to ensure a high level of network availability and performance while reducing cost\(^5\). This is a challenge aim, so in some cases the operators outsource the maintenance services, allowing them focusing more on their core businesses and becoming more flexible, as well as reducing cost. O’Shea (2006) stated that the annually savings in OPEX costs are up to 10 until 15 percent. According with the consulting firm Pyramid Research (2006), 47 percent of the mobile operators, outsource some or all of their spare parts management activities while wireline operators appear to be least open to outsourcing spare parts management, with 79 percent indicating that it is conducted by internal staff. In 2007 Pyramid Research conducted a global and regional survey on mobile operator’s spends on services. The category “spare part management, repair and replacement” shows an increase trend for the next years in outsourcing spend, going from $3904 US M in 2005 up to $5616 US M in 2010, i.e. 43.8 percent higher in 2010.

![Figure 1. Global Repair and Replacement and Spare Parts Provision and Management Spend](image)

And at region level the next table 1 indicates that Western Europe and Asia Pacific show stronger tendency toward outsourcing spare parts services than the other regions.

\(^{4}\) E.g. Verizon, AT&T, Telmex, Telefonica, etc. which would be considered the customer.

\(^{5}\) Maintenance and operation network cost is divided in CAPEX (Capital Expenditure) and OPEX (Operational Expenditure), CAPEX is related with spare investment, building, etc and OPEX for transportation, human labor, etc.
Table 1. Repair and Replacement and Spare Parts Provision and Management Spend by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>US$M</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa Middle East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>466</td>
<td>566</td>
<td>632</td>
<td>667</td>
<td>682</td>
<td>684</td>
</tr>
<tr>
<td>In-House</td>
<td></td>
<td>155</td>
<td>189</td>
<td>190</td>
<td>180</td>
<td>166</td>
<td>150</td>
</tr>
<tr>
<td>Outsource</td>
<td></td>
<td>311</td>
<td>377</td>
<td>442</td>
<td>487</td>
<td>516</td>
<td>534</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,683</td>
<td>1,889</td>
<td>2,034</td>
<td>2,125</td>
<td>2,169</td>
<td>2,180</td>
</tr>
<tr>
<td>In-House</td>
<td></td>
<td>561</td>
<td>630</td>
<td>610</td>
<td>574</td>
<td>527</td>
<td>477</td>
</tr>
<tr>
<td>Outsource</td>
<td></td>
<td>1,122</td>
<td>1,259</td>
<td>1,424</td>
<td>1,552</td>
<td>1,642</td>
<td>1,704</td>
</tr>
<tr>
<td>Central Eastern Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>397</td>
<td>447</td>
<td>467</td>
<td>476</td>
<td>479</td>
<td>480</td>
</tr>
<tr>
<td>In-House</td>
<td></td>
<td>132</td>
<td>149</td>
<td>140</td>
<td>128</td>
<td>116</td>
<td>105</td>
</tr>
<tr>
<td>Outsource</td>
<td></td>
<td>265</td>
<td>298</td>
<td>327</td>
<td>347</td>
<td>363</td>
<td>375</td>
</tr>
<tr>
<td>Western Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,811</td>
<td>1,892</td>
<td>1,941</td>
<td>1,963</td>
<td>1,974</td>
<td>1,977</td>
</tr>
<tr>
<td>In-House</td>
<td></td>
<td>604</td>
<td>631</td>
<td>582</td>
<td>530</td>
<td>480</td>
<td>432</td>
</tr>
<tr>
<td>Outsource</td>
<td></td>
<td>1,207</td>
<td>1,261</td>
<td>1,385</td>
<td>1,433</td>
<td>1,495</td>
<td>1,545</td>
</tr>
<tr>
<td>Latin America</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>504</td>
<td>580</td>
<td>624</td>
<td>648</td>
<td>659</td>
<td>661</td>
</tr>
<tr>
<td>In-House</td>
<td></td>
<td>168</td>
<td>193</td>
<td>187</td>
<td>175</td>
<td>160</td>
<td>145</td>
</tr>
<tr>
<td>Outsource</td>
<td></td>
<td>336</td>
<td>386</td>
<td>437</td>
<td>473</td>
<td>499</td>
<td>517</td>
</tr>
<tr>
<td>North America</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>996</td>
<td>1,069</td>
<td>1,123</td>
<td>1,162</td>
<td>1,189</td>
<td>1,206</td>
</tr>
<tr>
<td>In-House</td>
<td></td>
<td>332</td>
<td>356</td>
<td>337</td>
<td>314</td>
<td>289</td>
<td>264</td>
</tr>
<tr>
<td>Outsource</td>
<td></td>
<td>664</td>
<td>712</td>
<td>786</td>
<td>848</td>
<td>900</td>
<td>942</td>
</tr>
</tbody>
</table>

The numbers and trend in spare parts management outsourcing contracts shown in figure 1 and table 1, represent a growing opportunity in first place to give a high reliable after sales service and in second place to obtain a revenue streams and market for OEMs. Of course, capture this market is not easy and the OEM after-sales service parts supply chains need to face different challenges e.g. customer needs and behavior, logistic management, budget limit, IT infrastructure, product upgrades, phase-out products support, warranties, repair, customer support, customer installed base visibility, long supply and repair lead times, intermittent and probabilistic demand, integration and coordination between different echelons within the supply chain, variability across the entire supply chain, etc.

In the realm of service parts management, relationships between OEMs and operators are often established through service agreements that extend over a period of time. The details of these service agreements vary in nature depending in customer requirements e.g. response time, customer budget, etc. Then customer concern would be high network availability and OEM challenge would be to allocate and optimize resource to commit the agreement.

In a typical supply chain in this industry, circuit packs are produced at one or more factories, shipped to a distribution center and local warehouses for intermediate storage, ready to support customer demand. As circuit packs are remanufactured parts, the supply chain must also include remanufacturing vendors, so defective parts can be integrated into the spare pool after a recovery process as shown in figure 2.
The design and model for the after-sales service parts supply chain can not come from the manufacturing models as stated by Cohen (2006b) because of the following issues:

Table 2. Two supply chains compared Manufacturing versus After-Sales Service

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Manufacturing Supply Chain Management (MSCM)</th>
<th>After-Sales Service Supply Chain based on corrective maintenance</th>
<th>Based on predictive and preventive maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of demand</td>
<td>Predictable, can be forecast</td>
<td>Always unpredictable, sporadic</td>
<td>Predictable, can be forecast</td>
</tr>
<tr>
<td>Required response</td>
<td>Standard, can be scheduled</td>
<td>ASAP (same day or next day)</td>
<td>Standard, can be scheduled</td>
</tr>
<tr>
<td>Number of SKUs</td>
<td>Limited</td>
<td>15 to 20 times more</td>
<td>Limited</td>
</tr>
<tr>
<td>Product portfolio</td>
<td>Largely homogeneous</td>
<td>Always heterogeneous</td>
<td>Largely homogeneous</td>
</tr>
<tr>
<td>Delivery network</td>
<td>Depends on nature of product; multiple network necessary</td>
<td>Single network, capable of delivering different service products</td>
<td>Depends on nature of product; multiple network necessary</td>
</tr>
<tr>
<td>Inventory management aim</td>
<td>Maximize velocity of resources</td>
<td>Pre-position resources</td>
<td>Maximize velocity of resources</td>
</tr>
<tr>
<td>Reverse logistics</td>
<td>Doesn't handle</td>
<td>Handles return, repair and disposal of failed components</td>
<td>Doesn't handle</td>
</tr>
<tr>
<td>Performance metric</td>
<td>Fill rate</td>
<td>Product availability (uptime)</td>
<td>Fill rate</td>
</tr>
<tr>
<td>Inventory turns (the more the better)</td>
<td>Six to 50 a year</td>
<td>One to four a year</td>
<td>Six to 50 a year</td>
</tr>
</tbody>
</table>
After-Sales Service Parts Supply Chain System

According to table 2 column 3 the processes and tools to manage manufacturing goods in a cost effective manner don’t work well for after-sale service business on corrective maintenance, however manufacturing processes and tool work perfectly on predictive and preventive maintenance, as shown in column 4, which is the system that offers best level of reliability and quality of after sales services. Indeed it is proposed to implement as soon as possible the Supply Chain Management (SCM) information system adapted to manage preventive/predictive maintenance based on a master production schedule for spare parts and labor. Storage of SKU’s of critical spare parts could be made under the agreement of consigned inventory, with physical location very near the main line equipment or network.

In the after sale services industry there should be one of two fundamentals objectives. One, is to obtain a capability to render a better new service hat can be sold at a profit (capability to serve) and the second, is to improve an existing after sale service so as to improve performance and customer acceptance or reduce cost without sacrifice of customer acceptance either of which would lead to higher profits.

In meeting these challenges, certain authors have addressed this kind of problems. From a mathematical perspective the books of Sherbrooke (2004) and Muckstadt (2005) encompass the more relevant advances to model the system. From a business side, Ray (2004), Cohen (2006a), Cohen et al (2006b) discuss and suggest methodologies to properly manage the service supply chain.

The objective of this paper is to show a systemic approach similar to Cohen et al (2006a) involving the strategy, tactical and operational planning into an integrated manner, that helps the After-sales service organization to design and operate the supply chain.

AFTER-SALES SERVICE PARTS PROCESSES

For many years, Operators have been installed OEMs equipment over wide geographical regions and not just in-country, either globally, e.g. AT&T MPLS network largely built using Cisco Systems Inc. equipment, now has 1500 owned service nodes in 80 countries and remote access in a total of 148 countries, and still announced further network expansion⁶. Figure 3 illustrates current AT&T global network.

---

To keep operating the global network at peak performance around the clock is a big challenge. As indicated in figure 1, the tendency is to outsource these tasks with OEMs through maintenance contract agreements. Basically those agreements specify what would be the service/recovery network availability response time and at what service level agreement (SLA) that would be committed e.g. 90%, 95%. OEMs offer different services portfolio and they can be summarized in three levels as shown in figure 4.

Last figure illustrate how OEMs assume more customer risk as they provide higher quality services. This paper will focus only on spare management and repair service only, i.e. Return for Repair (RfR) and Advanced Exchange Parts (AE). The other two are more related with technicians and monitor maintenance systems. In an AE service the OEM ship the spare part to the Operator in advance of receipt defective part with a same day or next day response time. Once the OEM received the defective part back then he use to repair the part and restore the spare pool. In practice, this contract is use basically for

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After-Sales Service Parts Supply Chain System

Critical items\(^8\). In a RfR service, the Operator send a faulty part to the OEM, then the commitment is to return a good part to the Operator with a specify Turn-Around Time (TAT) e.g. 30, 60 or 90 days. Depending of repair TAT and contractual TAT the OEM needs to balance the differences between these two TATs through the use of a spare pool, e.g. if 30 days is contractually established and the repair TAT is 90 days, then the OEM will need to allocate some spare pool to meet customer agreement.

If a stock need to be positioned for AE and for some RfR contracts, then the question is of: what parts? And where to allocate them? In order to answer this question, the Operator installed base and where is it physically installed need to be listed at part level into the contract. Here it is very important to verify that the parts are current manufacturing available, otherwise sourcing phase-out items could be more problematic and there is not a guarantee to really get them as spares.

The next figures 5 and 6 illustrate the process that parts follow for the two different services. The numbers indicates the sequence of steps that each part follows into the supply chain. Color green arrows mean good parts and gray faulty parts. The figures also place insight in how the supply chain system is made of a set of interacting business partners sharing a particular purpose within a boundary. The most important supply chain system characteristic is the holistic properties (Jackson, 2003) i.e. the holistic properties are frequently greater than the arithmetic sum of the supply chain partners.

The use of 3PL within the supply chain to support warehousing and transportation operations is becoming more prevalent for the successful of service, because they provide flexibility to the supply chain (see Simchi-Levi et al 2003 for a discussion of advantages and disadvantages of 3PLs), so this is a common practice in today business operation.

Because of AE contracts has the shortest response time and the faulty part should be collect after the delivery of the good one, this kind of agreements are the most difficult to support, i.e. this type of service increase the variability into the supply chain and the response time commitment is more aggressive than RfR services.

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\(^8\) Critical items are those that when failed the effect has a great impact on Operator network availability.
In both service processes, failures occurrence variability, long repair and transportation TAT, high value spares parts, suppliers management, import/export country regulations, supply chain echelon integration and coordination, information visibility and tracking, budget boundary, customer support group efficiency, are typical issues that makes the challenge to deal with service operation more difficult. The OEM target is to design the supply chain that minimizes system wide cost while at the same time, meet customer agreements, i.e. make the supply-demand process match. Although uncertainty cannot be eliminated, the next section we will explore various approaches that could help to plan the supply chain service going from strategic through the tactical to the operational level.

**AFTER-SALES SERVICE PARTS SUPPLY CHAIN DESIGN**

In order to tackle the different challenges to support the supply chain, this section deals with the planning steps and information requirements we recommended to design and operate the system. The types of decisions that must be made relating to service parts management and repair can roughly be divided into three planning categories: *strategic, tactical* and *operational planning*. *Strategic* decisions are those that have a long lasting effect on the firm, *tactical* decisions are typically updated anywhere between once every quarter or month and *operational* decisions refers to day to day activity.

Strategic planning issues related with the design of the supply chain are:

a) *Service part portfolio*. Base on *AE* and *RfR* agreements the OEM should obtain information about the installed base of parts that need support, where these are located, the response time and the SLA to commit. In practice it is common to use *AE* contracts for critical parts and *RfR* for non-critical.
b) **Logistic network design.** Configuration network decision of warehouses and repair vendors location can be viewed as forward and reverse logistics network decisions. For forward logistics the objective is to commit contractual response time considering 3PL capabilities and others government or geographical constraints, etc. But the common rule is to set up with the 3PL distributed warehouses to commit AE same day delivery parts contracts and a centralized warehouse for AE next day delivery and/or R/R service parts contracts (see figure 7). It is recommended to considerer the centralized warehouse as the distribution center for the rest of distributed warehouses. This configuration has proven cost optimality into the supply chain (see the METRIC\(^9\) method by Sherbrooke 2004). Reverse logistic network must consider other elements e.g. the transportation cost, the repair capacity, annually average repair demand by location, so the systemwide repair cost can be minimize.

![figure 7. Connecting service strategy with criticality](image)

**Figure 7. Connecting service strategy with criticality**

c) **Master Part File.** This database enables the planning tool and organizations to know part detail information, e.g. phase-out parts, substitutes, descriptions, etc. This part must be included into the IT solution.

d) **3PL alliances.** 3PL arrangement involves long-term commitments related with warehousing, transportation and defective collect process. These alliances allow more flexibility in OEM assets and provide the opportunity to dedicate more to the core business. Simchi-Levi et al (2005) listed the issues and requirements that need to be considered in deciding to contract a particular 3PL: i) know your own cost, ii) customer orientation of the 3PL, iii) specialization of the 3PL and iv) Asset-owning versus non-asset owning 3PL.

e) **Budget.** This issue is considered as a constraint in terms of infrastructure investment.

f) **Master schedule.** For preventive/ predictive maintenance should be agreed between all involved managers from OEM’s, customers an 3PL’s

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\(^9\) METRIC: Multi-Echelon Technique for Recoverable Item Control, is a mathematical model developed by Sherbrooke to manage spare parts by the US Air Force while he was at the RAND Corporation in 1996.
After-Sales Service Parts Supply Chain System

Tactical planning issues:

a) **Demand analysis.** OEMs cannot produce service in advance, only for immediate consumption in response of a failure of the Operator installed equipment. There are two sources of information in order to forecast demand, failure parts records and Mean Time Between Failures (MTBF) by part number. As stated by Trindade et al. (2005) reliance on the MTBF without full understanding of the implication can result in missing developing trends and drawing erroneous conclusions. The idea is to use Mean Cumulative Functions (MCF) to present effective field data analysis instead which comprehend more the dynamics of demand.

b) **Lead times analysis.** The service supply chain has three different lead times: transportation time, repair TAT and defective collect time just for AE service contracts. The sources of variability in the three cases are different. Transportation time can be affected by international movements and depends on specific country regulations. Repair TAT variability depends on the capacity and effectiveness of the repair installation. Finally Defective collect time variability is link to customer performance. In Frei (2006) this last variability is call “Effort Variability”, i.e. “when a customer must perform a role in a service interaction, it’s up to them how much effort they apply to the task”. To resolve this issue he advises different strategies to pursue better performance, however an analysis need to be done previously to any recommendation. As higher lead time variability into the supply chain the outcome is worse performance. It is very important to monitor and find root causes to reduce as possible this type of variability.

c) **Optimum inventory position.** Once we have the information at the strategic level and the demand and lead time analysis the next step is to calculate the optimum spares pool allocation. During the life of the service agreement the investment on spares could be the highest cost, so it is recommended to use a model e.g. METRIC to pursue the objective.

d) **Inventory management.** Of spare parts should include lead time for all spare parts plus all critical related information, such as unit price, unit of measurement, numbers of part, etc.

Operational planning comes once we have the optimal inventory position calculated, for example inventory balances and replenishment, repair and defective collect prioritization, new inventory buys, scrapped analysis, etc. To optimize the cost Muckstadt (2005) constructed base on dynamic programming three different approximations: i) stock allocation model (SAM), which determines how many parts to ship from the distribution center to the distributed warehouses in each period of the planning horizon, the second is ii) the extended stock allocation model (ESAM) which is similar to SAM but now there is a possibility to use an expedite shipment mode from the distribution center warehouse, and the third is iii) extended stock allocation model with repair (ESAMR) that includes
the two previous models and the repair parts. The interrelation of the three planning levels and time horizons is shown in figure 8.

Figure 8. Planning Process.

Solving the problem of managing the inventories requires a probabilistic dynamic representation of the environment. So it is usually to make strategic modification in a long planning horizon, recalculate inventory and demand on a monthly or even weekly basis and plan for inventory allocation daily as well.

Once the supply chain and the services are operating, dynamical metrics (Keep Performance Indicator KPIs) should monitor the customer and supply chain performance. From a customer’s perspective, service quality is defined by delay of the part request and from the OEM supply chain perspective there are various measurements involve associated with the availability of the service. The principal is part fill rate, the fraction of demand for parts that is available in stock at the site receiving the demand.

The successful of supply chain integration stem from the fact of three elements as stated by Lee (2000) information sharing, coordination and organizational linkages between all the partners of the supply chain. Information Technology is a critical enabler of effective
After-Sales Service Parts Supply Chain System

supply chain management. To accomplish this, different business systems need to be linked so the information integration can be realized (see figure 9).

Enterprise Resource Planning (ERP) encompasses the different activities into a company and can be considered as the backbone of IT infrastructure. Nowadays ERP systems should organized an enterprise completely according to customer needs, regarding the business environment of the enterprise as a supply chain including, repair vendors, manufactories, 3PLs network, OEM logistics networks and customers (see Zhang et al 2006). They do not, however, help answer the fundamental question of what should be made, where, when, and for whom. This is the role played by human planners with the aid of various analytical tools such as decision-support systems (DSS) planning tool. Also it is important to integrate Repair management system, 3PL system and Customer Relations Management (CRM) system information, so the DSS planning system integrate all the information and planning take into consideration the total supply chain. Analyzed data will depend on quality data, also information flow need to be synchronized with material flow.

Figure 9. Information integration system.

CONCLUSION

The presented work proposes a systematic approach of how OEM firms can plan the service solution through the supply chain from strategic through tactical and finally operational planning. This solution embraces operation research supply chain models and concepts, the use of IT systems and manager skills focus on service offerings. Although there are great developments in technology and business models, the integration of a
global service parts supply chain is still challenging. The new concept in OEM services is Multivendor support, i.e. be a single point of contact to customers, supporting different OEMs products. The risk to handle this service is still higher than the Advance Exchange services because more variability is infected into the processes. The after sales Supply Chain of spare parts and services must be transformed as soon as possible from a 100% corrective maintenance system to a 99% predictive/ preventive maintenance system. Concepts from system theory, knowledge management, complex systems, etc can also be analyzed in a future research to incorporate methodologies or concepts that help better understand the dynamics of the supply chain service part system

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ANALYSIS ON TRUST GAME BY RECIPROCAL AGENTS

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ABSTRACT

In this paper, the author proposes a game-theoretical model of trust among reciprocal agents. Our model, a trust game, is a non-cooperative game in extensive form. By considering about this game, we can define clearly the concept of trust behavior in general games in extensive form. But just using ordinary equilibrium concept (e.g. subgame perfect equilibrium), we cannot explain the trust behavior in some situations. This result contradicts with some observations in real world. So, we have to adopt another solution concept, sequential reciprocity equilibrium (SRE), which is suggested by Dufwenberg. Adopting this SRE concept, we analyze repeated trust game (RTG). As a result of analysis, I find the condition of reciprocity to trust others, and reciprocal agents can get higher payoff than non-reciprocal agents when the length of game is enough long.

Keywords: Game Theory; Trust; Reciprocity; Social Network

1. INTRODUCTION

The purpose of this research is to develop a game theoretical model of trust among reciprocal agents. Through analysis on this model, we find conditions of establishing trust relation. This study can be employed for further application: for example, mechanism designs for creating highly-trust social network, evaluation for strength of trust relation between service provider and consumer, etc.

Trust has been studied in many areas, sociology, economics, politics, anthropology, psychology and so on. These studies can divides into three approaches. (Sato, 1999) First one is functionalistic approach, which views trust as a function in social systems, as represented by Luhmann. He insisted that trust is a mechanism for reduction of complexity. Secondly, psychological approach supposes trust as a personal characteristic. On this approach, researchers compare the tendency of trust among countries, cultures etc. by experiments and surveys. The last one is rationalistic approach, which develops trust model and analyzes it by economic method, e.g. game theory, expected-utility theory. The
representative study from this approach is Coleman’s theory based on rational choice theory. He established a trust model, and explained “place trust in others” action by utility-maximize action. (Coleman, 1990) We adopt this rationalistic approach.

The structure of this paper is as follows: in Section 2, a basic model of trust, we call “trust game”, will be suggested. For analyzing this model, we introduce a special equilibrium concept, sequential reciprocal equilibrium, in Section 3, and we adopt this concept for trust game and repeated trust game in Section 4. Finally, Section 5 is devoted to mention concluding remarks and further study.

2. MODEL: TRUST GAME

We start with Coleman’s trust model, which expressed trust as risky decision making. It is extensive form game illustrated in Figure 2.1. This game is played by two players, Truster and Trustee. Just considered Truster’s utility, Trustee make a probabilistic choice between ‘Trustworthy’ and ‘Not Trustworthy’. Supposing that probability of choosing ‘Trustworthy’ is $p$, potential gain and loss of Truster when Trustee chooses ‘Trustworthy’ and ‘Not Trustworthy’ is $G$ and $L$ respectively. In this trust model, we can obtain a condition below about Truster’s rational decision making immediately.

- Truster place trust if and only if $p > \frac{L}{G+L}$
- Truster don’t place trust if and only if $p < \frac{L}{G+L}$

![Figure 2.1 Coleman’s Trust Model](image)

Generally speaking, probability $p$ is not known to Truster, so a mechanism of shaping expectation on Trustee’s action is interesting. But Coleman’s model cannot explain how Truster’s expectation shapes, because it treats Trustee’s action probabilistically.

To solve this problem, we develop Coleman’s model into trust game in Figure 2.2 by introducing Trustee’s utility. The following is subgame perfect equilibrium of this game.
Analysis on Trust Game by Reciprocal Agents

- If $0 < b < 1$, subgame perfect equilibrium is $(T, r)$
- If $1 < b$, subgame perfect equilibrium is $(N, e)$

![Figure 2.2 Trust Game]

Even though $1 < b$, we can observe Truster(Player 1) places trust on Trustee(Player 2) and Trustee rewards Truster’s trust in real life. To explain this phenomenon, we introduce other-regarding preference. Specifically, we adopt other equilibrium concept, which is considered with agents’ reciprocity in next section.

3. EQUILIBRIUM CONCEPT

This section gives the definition of sequential reciprocal equilibrium (SRE). (Cox, 2004) define that (positive) reciprocity is a motivation to repay generous or helpful actions of another by adopting actions that are generous or helpful to the other person, which distinct from the unconditional kindness motivated by altruism. But how generous or helpful Player 1’s action is for Player 2 depends on the 2’s belief on 1’s action as well as 1’s action itself. So utility function is not only determined by pair of strategies, but also pair of players’ beliefs. It is the essence of psychological game (Gianakoplos et al., 1989), on which SRE concept is based. (Dufwenberg et al., 2004) defined SRE as below.

Let $N = \{1, 2, \ldots, n\}$ be the set of players. Let $H$ be the set of choice profiles, or histories. Let $A_i$ be the set of behavior strategies of $i \in N$. Define $A = \prod_{i \in N} A_i$. Let $\pi_i : A \rightarrow \mathbb{R}$ be player $i$’s material payoff function. Let $B_{ij} = A_j$ be the set of possible beliefs of player $i$’s about the strategy of player $j$. Let $C_{ijk} = B_{jk} = A_k$ be the set of possible beliefs of player $i$’s about the belief of player $j$ about the strategy of player $k$. With $a_i \in A, h \in H$, let $a_i(h)$ be the update strategy that prescribes the same choices as $a_i$, except for the choices that define history $h$ which are made with probability 1. For $b_{ij} \in B_{ij}, c_{ijk} \in C_{ijk}$, define update beliefs $b_{ij}(h), c_{ijk}(h)$ in same fashion to update strategies.

Here we move on to kindness and utility function, which appeared in definition of SRE.
Analysis on Trust Game by Reciprocal Agents

**Definition 3.1 (kindness)**

The kindness of player \( i \) to another player \( j \neq i \) at history \( h \in H \) is given by the function

\[
\kappa_i : A_i \times \prod_{j \neq i} B_j \rightarrow \mathbb{R}
\]

defined by

\[
\kappa_i(a_i(h),(b_{ij}(h))_{j \neq i}) = \pi_j(a_i(h),(b_{ij}(h))_{j \neq i}) - \pi^e_j((b_{ij}(h))_{j \neq i})
\]

\( \pi^e_j((b_{ij}(h))_{j \neq i}) \) is the equitable payoff for player \( j \), defined by

\[
\pi^e_j((b_{ij}(h))_{j \neq i}) = \frac{1}{2} \left[ \max_{a_i \in \mathbb{A}_i} \pi_j(a_i(h),(b_{ij}(h))_{j \neq i}) + \min_{a_i \in \mathbb{A}_i} \pi_j(a_i(h),(b_{ij}(h))_{j \neq i}) \right]
\]

**Definition 3.2 (belief about kindness)**

Player \( i \)'s beliefs about how kind player \( j \neq i \) is to \( i \) at history \( h \in H \) is given by the function

\[
\lambda_{ij} : B_i \times \prod_{k \neq j} C_{ik} \rightarrow \mathbb{R}
\]

defined by

\[
\lambda_{ij}(b_{ij}(h),(c_{ijk}(h))_{k \neq j}) = \pi_i(b_{ij}(h),(c_{ijk}(h))_{k \neq j}) - \pi_i^e((c_{ijk}(h))_{k \neq j})
\]

**Definition 3.3 (utility function)**

Player \( i \)'s utility at history \( h \in H \) is a function

\[
U_i : A_i \times \prod_{j \neq i} (B_j \times \prod_{k \neq j} C_{jk}) \rightarrow \mathbb{R}
\]

defined by

\[
U_i(a_i(h),(b_{ij}(h),(c_{ijk}(h))_{k \neq j})_{j \neq i}) = \pi_i(a_i(h),(b_{ij}(h))_{j \neq i}) + \sum_{j \in \mathbb{N} \setminus \{i\}} (Y_{ij} \kappa_j(a_i(h),(b_{ij}(h))_{j \neq i} \cdot \lambda_{ij}(b_{ij}(h),(c_{ijk}(h))_{k \neq j}))
\]

Especially in case of \( N = \{1,2\} \), utility functions are following,

\[
U_1(a_1(h),b_{12}(h),c_{121}(h)) = \pi_1(a_1(h),b_{12}(h)) + Y_{12} \cdot \kappa_{12}(a_1(h),b_{12}(h)) \cdot \lambda_{21}(b_{21}(h),c_{212}(h))
\]

\[
U_2(a_2(h),b_{21}(h),c_{212}(h)) = \pi_2(a_2(h),b_{21}(h)) + Y_{21} \cdot \kappa_{21}(a_2(h),b_{21}(h)) \cdot \lambda_{12}(b_{12}(h),c_{212}(h))
\]

**Definition 3.4 (SRE)**

The profile \( a^* = (a_i^*)_{i \in N} \) is sequential reciprocity equilibrium (SRE) if for all \( i \in N \) and for each history \( h \in H \) it holds that

- \( a_i^* \in \arg \max_{a_i \in \mathbb{A}_i(h)} U_i(a_i(h),(b_{ij}(h),(c_{ijk}(h))_{k \neq j})_{j \neq i}) \)

\( A_i(h,a) \subseteq A_i \) is the set of strategies, that prescribe the same choices as the strategy \( a_i(h) \) for all histories other than \( h \).

- \( b_{ij} = a_j^* \) for all \( j \neq i \)
- \( b_{ijk} = a_k^* \) for all \( k \neq j \)
Analysis on Trust Game by Reciprocal Agents

As above, this definition consists of three conditions, ‘utility maximization’, ‘consistency with first-order belief’ and ‘consistency with second-order belief’. If $Y_{ij} = 0$ for any $i, j$, each player is motivated by material payoff. In this case, SRE is same as subgame perfect equilibrium.

4. ANALYSIS

**Trust Game**

Then, we complete the preparation of equilibrium concept. Using SRE, we begin to analysis on trust game in this section. We simplify notation $Y_1$ and $Y_2$ instead of $Y_{12}$ and $Y_{21}$, since we analyze only two-player games.

**Figure 4.1 Trust Game**

**Proposition 4.1**

For any SRE $a^*, a^*_1 = T$ and $Y_2 > \frac{2(b-1)}{a+1} \Rightarrow a^*_2 = r$

(Proof)

Focused on 2’s decision making. 1’s equitable payoff is $\pi_1^e = \frac{1-a}{2}$. Then 2’s kindness to 1 is $\kappa_21(r) = 1 - \pi_1^e = \frac{1+a}{2}, \kappa_21(e) = -a - \pi_1^e = -\frac{1+a}{2}$. Supposing that 2’s belief on 1’s belief about 2’s strategy is $c_{212} = p''r + (1 - p'')e$. Then 2’s equitable payoff is $\pi_2^e = \frac{1}{2}((p''1+(1-p'')b)+0)$. Therefore 1’s belief on 2’s kindness to 1 is $\lambda_{122}(T, p''r + (1 - p'')e) = \frac{1-b}{2}p'' + \frac{b}{2}$. Hence 2’s utility as follows

- 2 chooses strategy ‘r’, $U_2' = 1 + Y_2(\frac{1+a}{2})(\frac{1-b}{2}p'' + \frac{b}{2})$
- 2 chooses strategy ‘e’, $U_2'' = b + Y_2(-\frac{1+a}{2})(\frac{1-b}{2}p'' + \frac{b}{2})$
Analysis on Trust Game by Reciprocal Agents

\[ U_2' > U_2'' \iff 1 - b + 2Y_2 \left( \frac{1 + a}{2} \right) \left( \frac{1 - b}{2} p'' + \frac{b}{2} \right) > 0 \]

By consistency condition \( p'' = 1 \), we obtain \( Y_2 > \frac{2(b - 1)}{a + 1} \).

Next proposition can be proved similarly fashion to Proposition 4.1.

**Proposition 4.2**

For any SRE \( a^* \), \( Y_2 > \frac{2(b - 1)}{a + 1} \) \( \implies a^*_1 = T \)

From proposition 4.1 and 4.2, following theorem derived immediately.

**Theorem 4.3**

If \( Y_2 > \frac{2(b - 1)}{a + 1} \), unique SRE is \( a^* = (a^*_1, a^*_2) = (T, r) \)

**Repeated Trust Game (RTG)**

Next, we try to analyze repeated trust game (RTG), which is illustrated Figure 4.2. Nodes with Odd number are 1’s move, the others are 2’s move. Supposing that total number of move \( M \) is even. On each move, player has two alternatives \( T_i \) and \( N_i \), corresponding to T and N in trust game respectively. If 1 chooses \( T_k \) and 2 chooses \( T_{k+1} \), both players’ payoff increase 1. On the other hand, though 1 chooses \( T_k \), 2 chooses \( N_{k+1} \), 1’s payoff decrease \( a(0 < a < 1) \) and 2’s payoff increase \( b(1 < a < 2) \) and the game is terminated. If 1 chooses \( N_k \), the game is over without payoff change. Think along the similar analysis on trust game, we try to find conditions for trust actions included in SRE.

![Figure 4.2 Repeated Trust Game](image-url)
Analysis on Trust Game by Reciprocal Agents

Proposition 4.4

For any SRE \( a^* \), which reaches node M, \( Y_2 > \frac{4(b-1)}{M(a+1)} \Rightarrow a^*_2 = (\ast, \cdot, \cdot, T_M) \)

(Proof)

Focused on 2’s decision making on node M. 1’s equitable payoff is \( \pi^*_1 = \frac{M}{4} - \frac{a}{2} \). Then 2’s kindness to 1 is \( \kappa_{21}(T_2, \cdot, \cdot, T_{M-2}, T_M) = \frac{M}{4} + \frac{a}{2} \), \( \kappa_{21}(T_2, \cdot, \cdot, T_{M-2}, N_M) = \frac{M}{4} - \frac{a}{2} - 1 \).

Supposing that 2’s belief on 1’s belief about 2’s strategy is \( c_{212} = (T_2, \cdot, \cdot, T_{M-2}, p' 'T_M + (1 - p' ')N_M) \). Then 2’s equitable payoff is \( \pi^*_2 = \frac{M}{4} + \frac{1 - p' '}{2}(-1 + b) \). Therefore 1’s belief on 2’s kindness to 1 is \( \lambda_{121}(T_2, \cdot, \cdot, T_{M-2}, p''T_M + (1 - p' ')N_M) \). Hence 2’s utility as follows

- 2 chooses strategy \( T_M \), \( U_2 ' = \frac{M}{2} + Y_2 (\frac{M}{4} + \frac{1 - p'}{2}(-1 + b))(\frac{M}{4} + \frac{a}{2}) \)

- 2 chooses strategy \( N'_M \), \( U_2 '' = \frac{M}{2} + Y_2 (\frac{M}{4} + \frac{1 - p''}{2}(-1 + b))(\frac{M}{4} - \frac{a}{2} - 1) \)

\( U_2 ' > U_2 '' \iff 1 - b + Y_2 (\frac{M}{4} + \frac{1 - p'}{2}(-1 + b)(a + 1)) > 0 \)

By consistency condition \( p' ' = 1 \), we obtain \( Y_2 > \frac{4(b-1)}{M(a+1)} \).

Proposition 4.5

For any SRE \( a^* \), if there exists \( k \) such that players choose \( T_k \) at any node \( k' (k < k' \leq M) \), players choose \( T_k \) at node \( k \).

(Proof)

Supposing that \( k \) is odd.

- 1 chooses strategy \( T_k \), \( U_2 ' = \frac{M}{2} + Y_1 \cdot \kappa_{12}(\ast, \cdot, \cdot, T_k, T_{k+2}, \cdot, T_{M-1}) \cdot \lambda_{121}(\cdot) \)

- 1 chooses strategy \( N'_k \), \( U_2 '' = \frac{k - 1}{2} + Y_1 \cdot \kappa_{12}(\ast, \cdot, \cdot, N_k, T_{k+2}, \cdot, T_{M-1}) \cdot \lambda_{121}(\cdot) \)

Because of \( b_{12} = (\ast, \cdot, \cdot, T_{k+1}, \cdot, T_M) \), \( \kappa_{12}(\ast, \cdot, \cdot, T_k, T_{k+2}, \cdot, T_{M-1}) - \kappa_{12}(\ast, \cdot, \cdot, N_k, T_{k+2}, \cdot, T_{M-1}) = \frac{M}{2} - \frac{k - 1}{2} > 0 \). Hence 2’s
utility as follows. \( U_2' = U_2'' = \left( \frac{M}{2} - \frac{k-1}{2} \right) + Y_1 \left( \frac{M}{2} - \frac{k-1}{2} \right) \cdot \lambda_{121} (\cdot) > 0 \). Therefore player choose \( T_k \) at node \( k \). We can prove similarly when \( k \) is even.

\[
\begin{align*}
&k(1) \\
&T_k \quad \text{M/2} \\
&N_k \quad \text{M/2} \\
&(k-1)/2 \\
&(k-1)/2
\end{align*}
\]

**Figure 4.3 Decision Making on Node k (k: odd)**

Combined these propositions, following theorem can be proven inductively.

**Theorem 4.6**

If \( Y_2 > \frac{4(b-1)}{M(a+1)} \), unique SRE is \( a^* = (a^1, a^2) = ((T^1, \cdots, T^{M-1}), (T^2, \cdots, T^M)) \)

5. **CONCLUSIONS**

This paper gave a game theoretical model of trust. Introducing SRE concept, ‘place trust’ and ‘reward’ action could be expressed as a solution of extensive form game. Through analysis on repeated trust game, we found the condition for building trust among reciprocal agents. The main outcome is Theorem 4.6; it shows that the longer RTG, the easier to build trust relation between agents. The next step of this research is extending the number of players. Though SRE concept could be adopted for game played by 3+ players, the analysis may be too complicated to solve algebraically. So, agent-based simulation will be powerful tool for analysis.

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Analysis on Trust Game by Reciprocal Agents

A BOUNDARY CRITIQUE OF GENDER IN THE PROJECT MANAGEMENT BODY OF KNOWLEDGE®

Pamela Buckle Henning & Janice Thomas

ABSTRACT

The Project Management Body of Knowledge (PMBOK®) is a document describing appropriate reasoning styles and behaviour for project managers. As a codified “body of knowledge,” it acts as a knowledge system for the profession. This codification is tacitly gendered, privileging masculine cognition and action. We examine how this tacit value system has de-legitimized certain feminine contributions to the profession, leaving them outside its boundaries of recommended practice. This boundary critique advocates on behalf of our emancipatory interests in improving the effectiveness of individual project managers, and the success of the profession itself.

INTRODUCTION

In any designed system of ideas, decisions get made about its limits – what the system should include and therefore endorse, and what the system should exclude and therefore discourage. Project Management Institute (PMI) is an association committed to the growth and reputation of the fledging project management profession. PMI has authored the Project Management Body of Knowledge ® (PMBOK) – a system of ideas and principles about what it means to be a project manager and how to manage projects well. This article examines limits of the PMBOK as a system of ideas, and what decisions were tacitly made by PMI about what kinds of thought and action are worth endorsing in the project management endeavour and what kinds are not. We draw from critical systems theory to inform this task.

The critical systems theory literature examines system designers’ assertions of rightness – i.e. what knowledges should be deemed relevant and which should be left out. Critical systems theory is an invitation to doubt, calling into question judgments made about the placement of a system’s boundaries, and asking whether those boundaries are drawn widely enough.

This critical examination of the PMBOK is a modest attempt at boundary critique. Ulrich (Jackson, 1991; Ulrich, 2005) lays out several tasks for effective boundary critique:

- Identifying “sources of selectivity” conditioning claims about why a system was designed as it was;
- Examining implications of such selectivity, practically and ethically; and
We take Ulrich’s tasks as guides for boundary critique in our analysis of PMBOK.¹

We focus in this article on one source of selectivity that underpins this system’s normative claims: gender. We examine forces that gave rise to the PMBOK, and the notion of gender as a usually-tacit value system in management discourse in the pages that follow.

**THE PMBOK DISCOURSE**

Project management has been a recognized discipline in organizations since the 1950s. PMI works to legitimize project managers’ growing status as a group of experts skilled at managing a mode of working heralded by some organizational scholars as “the future of work” (Bennis, 1968; Clegg, 1989; Weick, 1995; Peters, 1999). Since 1969, the Project Management Institute in the United States (PMI) has been the predominant professional association for project managers in North America and, some would argue, worldwide. It has taken a stewardship role in promoting the establishment of project management standards, training, and education. A key drive for the organization has been the spread of understanding and appreciation for the skills and behaviours collectively termed *project management*. In the 1980s, PMI’s focus turned to defining project management. In 1996, *PMBOK* resulted – a 216-page book documenting “generally-accepted” body of project management knowledge, providing a common language for project managers and common standards of project management quality, excellence, and professionalism. We take the 2000 edition of *PMBOK* as a system of ideas, representing this profession’s efforts to claim respectability in contemporary organizations.

PMI’s intent in developing *PMBOK* was to create a formalized – and therefore boundaried – system of knowledge for the profession. The *PMBOK*’s authors were a group of respected project managers and project management scholars – thereby making PMI’s attempt at prescribing professional behaviour a top-down effort. Increased respectability for the profession was PMI’s aim in this endeavour. Codification of its knowledge base was an appropriate means to this end.

One of the most potent acts of power is “the structuring of the world-views of others” (Thomas and Lockett, 1991, 93), which *PMBOK* is designed to do, both for aspiring project managers and the organizations that hire them. Documenting information gives the impression of fixing it, reaching a state of certainty about meanings that may have been previously unresolved prior to being captured in written form. When a profession seeks to codify its body of knowledge, it seeks to create closure on the spectrum of acceptable behaviours and thought processes available to individuals who seek to identify themselves with this profession. To a critical systems theorist,

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¹ Ulrich posits the tasks of boundary critique as “systematic.” We agree, although we do not treat his prescriptions sequentially in this data analysis.
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codification is a political act, as the documenting of legitimate professional knowledge amounts to normative claims about what the profession is and stands for.

One way to understand *PMBOK* as both a system of professional knowledge and a political act is to examine the dimension of gender. Gender, we argue, is an important source of selectivity conditioning PMI’s claims of what it means to be a member of the project management profession.

**GENDER AS MEANS OF COGNITION AND BEHAVIOUR**

Empirical study supports the view that the work world, and perceptions of success held by both practitioners and scholars, are gendered (Acker, 1990; Gherardi, 1994; Fletcher, 1998; Hale, 1999; Nelson and Robinson, 1999). Although the literature generally remains silent on the matter, the ways project managers frame their deliverables, their understanding of how to effectively mobilize a team, and their tendency to focus their energies on task or human aspects of the project management role are all gender-laden (Meyerson and Fletcher, 2000), shaped by normative expectations about how to be seen as competent. Feminist researchers have noted that we commonly see the desire to be competent expressed in two patterns of cognition and behaviour: masculine and feminine.²

**Masculine Modes of Thought and Action**

The masculine sensemaking style tends to value analytical and impersonal problem solving (Eagly and Johnson, 1990; Magolda, 1992; Daley and Naff, 1998; Hughes, 2000). Individuals with strong masculine styles hold a value system focusing on mastery over their environment (Keller, 1978; Eagly and Johnson, 1990; Hughes, 2000; Martin, 2000). They apply objective and impersonal criteria to decision-making, taking an adversarial stance in evaluating information (Magolda, 1992; Clinchy, 1996; Belenky, Clinchy et al., 1997). Their reasoning styles offers detachment from the individuals and situations they seek to understand (Melymuka, 1999). This detachment is termed “field independence,” and manifests in a person’s preference to fidelity and conformance to predetermined models of project reality, and preference to execute tasks according to those predetermined views, regardless of the peculiarities of the specific situation (Haaken, 1988).

People with highly developed masculine behaviours tend to exhibit strengths in maintaining an appearance of assertiveness, masterfulness, and control (Kerfoot and Knights, 1993) – often collectively termed agentic qualities (Eagly, Makhijani et al., 1992). People with strong masculine managerial skills tend to be highly task-oriented, excelling at initiating structure through the development of roles and procedures, making

² It is necessary to stress that the gendered tendencies described below are not prescriptions for men and women (Nelson, E. D. and B. W. Robinson (1999). *Gender in Canada*. Scarborough ON, Prentice Hall.
leader and subordinate roles explicit, and ensuring team members effectively follow prescribed structures in order to maintain high performance standards (Ibid.).

**Feminine Modes of Thought and Action**

The feminine sensemaking style involves placing primacy on one’s connection with others (Clinchy, 1996; Belenky, Clinchy et al., 1997; Fletcher, 1998). Such individuals value sharing power (Martin, 2000), prizing democratic or participative decision-making (Eagly, Makhijani et al., 1992; Tarule, 1996), and tend to create cooperative work settings (Belenky, Clinchy et al., 1997; Hughes, 2000).

People with highly developed feminine behaviours tend to excel in skills of empathy (Clinchy, 1996), collaborative sensemaking and working styles (Tarule, 1996), and a sensitivity to situations’ emotional contexts (Gilligan, 1977; Eagly and Johnson, 1990; Fletcher, 1998). As managers, they tend to develop strong networks of information and power sharing (Daley and Naff, 1998), contribute to the power and status of others (Gherardi, 1994). Overall, their workplace behaviours can be characterized as highly interpersonal. Feminine cognition can be viewed as “field dependent,” focusing on conceiving of tasks and plans through consideration of the particular, idiosyncratic demands of the moment. Field dependent behaviour is informed primarily in response to emerging realities, relationships, and information (Haaken, 1988).

We stress again that “there are no pure groups” (Walby, 2007, 452). Rather, following the psychological theories of Jung (1959a;b), we focus here on masculinity and femininity as value systems not constrained to biologically male or female individuals. In the project management profession, many female project managers enjoy substantial success by virtue of their highly developed masculine ways of thinking and acting. Many male project managers have exceptionally well developed feminine thought and behavioural skills they can call upon in delivering their projects to successful conclusions (Thomas and Buckle Henning, in press). Rather, our concern was understanding the degree to which masculine and feminine thought and action were positioned as legitimate parts of the *PMBOK* interpretive system, and by contrast, how certain gendered thinking and actions were rendered absent as valued ways to approach one’s project work and the implications of this orientation to the redefinition of work.

While we believed that both masculine and feminine ways of knowing and being in workplaces are undoubtedly valuable for project management (and are equally complex [(Magolda, 1992)], they are not equally valued. *While feminine thought and behaviour is not absent in PMBOK, it is often portrayed as suspect or inferior.*

The analysis presented here focuses on PMI’s conceptualization of project management, the role of project managers, and the notion of risk (i.e. forces that threaten or inhibit the successful completion of projects). Unless otherwise noted, all citations come from the *PMBOK*’s 2000 edition.

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**PMBOK ANALYSIS**

**Conceiving of Project Management**

Definition: “Project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements.” *(PMBOK, 2000, 6)*

In *PMBOK*, project management is framed as a task focused, instrumental business process.

Masculine and feminine reasoning styles inform differing perceptions about what project management work is all about. The masculine view has clearly delineated ideas of what should fall within the scope of a project, and what should be considered extraneous. It places great importance on discerning a project in terms that “[include] all the work required, and *only* the work required” (our emphasis – p. 7), seeking to create a singular reality that eliminates information, events, persons, and agendas from the manager’s field of vision that could distract from this conception of reality. The basic thrust to develop a conception of project objectives and processes, and to preserve this perception intact, appears throughout the advice about appropriate project management reasoning styles and processes: “Sequential logic [is] designed to ensure proper definition;” and “numerous forms, charts, and checklists... provide structure and consistency... called project management methodologies... divide each project into several project phases to improve management control” (p. 11-12).

Such desire for clarity, control, and the cognitive filtering processes described above, are invaluable tactics to serve motives of efficiency. Under such logic, a competent project manager does what s/he needs to do to clear the most direct possible route between point A (the present) and point B (the desired state of project completion). Plural or shifting views of either point create uncertainty and hamper efficiency; masculine logic prefers to construct reality (processes, deliverable, and overall project objectives) in terms of what can be best controlled; that which is difficult or impossible to control is interpreted as deviant or problematic.

Feminine reasoning operates on a broader perception of what falls into the realm of project work. If the central *modus operandi* of masculinity is a preference for control, feminine reasoning utilizes a more fluid, responsive orientation to emergent project realities. Feminine thought processes note that projects have “stakeholders with differing needs and expectations” (p. 6). Stakeholder orientation encourages acknowledgement and acceptance of multiple project realities depending on the events that unfold and the players involved. This orientation also sounds much like (Checkland, 1991)’s report of Vickers’ systems approach: “[his] concept of relationship-maintaining was more fruitful than that of goal-seeking, being not only closer to reality but also overcoming the problem of treating as fixed an element you know is really continually changing” (p. 64)

Masculine reasoning believes that project management requires decision making informed by a relatively fixed normative view of what is and what must be done. By
contrast, feminine cognition moves from the present moment toward a project end state that is provisional and acceptably uncertain. Such uncertainty demands continually monitoring the environment for cues that affirm the appropriateness of the original project goal or suggest it needs to be revisited. Thus, such uncertainty enables a project manager to more easily discover, adapt, and design appropriate action as s/he moves through time.

Inherently, a feminine orientation of the goals and processes of project management is neither positive nor negative; however, PMBOK frames the effects of this orientation as problematic. The book expresses a preference for clear, masculine, unified views in its warning that “different objectives [for a project] may come into conflict” (p. 17); PMBOK does not acknowledge that the expression of multiple objectives also enables a greater understanding of the interests and needs of users, increasing the likelihood that more users will be satisfied by the project’s end result. Similarly, the document reveals discomfort with the unknown: “The probability of successfully completing the project is lowest, and hence risk and uncertainty are highest, at the start of the project” (p. 12). A project’s beginning is the point at which a project possesses its greatest potentiality, opportunity for creativity and innovation; it is also the point at which a masculine-oriented project manager has the least clarity and guidance about what s/he is to perform. PMBOK frames the initial stages as fraught with the threat of failure – an assessment that makes a great deal of sense to masculine reasoning and less sense to feminine reasoning.

Role of Project Manager

Nowhere in PMBOK is there a concise definition of the role of a project manager. What can we infer from this choice to leave the role of the person of the project manager tacit? We speculate that a profession intent on institutionalizing its discipline as a bona fide and valuable business process might view the depersonalized approach to explaining the role of project managers as consistent with this aim. Depersonalization is also a tendency of masculine approaches to organizational practice.

The masculine manager views him- or herself as separate from surrounding reality. This orientation favours acting on her or his environment according to preconceived plans and predefined conceptions of success: “The project management team must identify the stakeholders, determining their requirements, and then manage and influence those requirements to ensure a successful project” (our emphasis – p. 16). This sequence is carried out from a stance apart from the reality the project manager must impact. The external environment is a force to be reckoned with in terms of its malleability or rigidity in supporting or inhibiting the attainment of stated project aims: for example, “the structures of the performing organization often constrains the availability of, or terms under which resources become available to the project” (our emphasis – p. 19) and “the project team must periodically measure itself against the expectations of those outside the project” (our emphasis – p. 119). The masculine mind

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4 Finally, in late 2002, perhaps in recognition of this gap, PMI released a statement defining the project manager’s role in some detail and describes the competencies necessary to fulfill this mandate.
views environmental people and events, whether friendly or resistant, as forces to be influenced and acted upon.

Much organizational literature supports the masculine logic. *PMBOK* cites definitions of “power” by Pfeffer (1992) and Eccles et al (1992): “to get people to do things that they would not otherwise do,” and “getting collective action from a group” (p. 26). “Getting” action from people is an agentic orientation to human relationships (Eagley et al., 1992) characterized as strongly masculine and evident throughout *PMBOK*’s descriptions of the project manager’s work. In the statement, “Most projects are performed by a team created for the sole purpose of performing the project, and the team is disbanded when the project is complete” (p. 5), both projects and people are positioned as means to a desired organizational end. People and processes, in this view, are tools or inputs the project manager uses to perform project tasks.

If the masculine orientation to a project manager’s activity is conceived as acting on environments and people to achieve project aims, the feminine approach is oriented toward acting with people, circumstances, and environments to realize desired objectives. Action is achieved through unfolding coordination of relationships. The strongly feminine project manager has an interest and readiness to respond to environmental changes – not to brace against challenges to the initial project plan (a masculine motivation). Rather, the effort is to determine how changing circumstances may be worked with to create consensually-defined success. The subtleties and complexities of project progress are noted: for example, “the nature and number of project stakeholders will often change as the project moves from phase to phase of its life cycle” (p. 108); and “roles and responsibilities may vary over time” (p. 110). Accepting these complexities, the feminine mode of acting with people and processes to carry out project asks evolves fluid response strategies to recognize and work with shifting project realities. Essentially this is a strategy of adaptable readiness: “The results of [formal planning processes] should be reviewed regularly… to ensure continued applicability” (p. 109); and, “Leadership… may be demonstrated by many different individuals at many different times during the project” (p. 24). While the masculine orientation gets others to execute project plans, the feminine approach engages in “coordinating people and other resources to carry out the plan” (p. 30), connoting a power with orientation to managerial influence.

We leave our analysis of the role of the project manager with a final thought. *PMBOK* uses the words perform, performs, performing, and performance to outline appropriate project management behaviour. Terms commonly found in theatre, perform and its derivatives connote execution of a preplanned script for an audience’s benefit. Such execution is roughly equivalent to the masculine orientation of working to maintain loyal to original project specifications (i.e. “the script”). Curiously, the complementary terms – improvise, improvises, improvisation – fall nowhere in *PMBOK*’s lexicon on the project manager’s role. In theatre, successful improvisation is considered a far more difficult way to relate to a scene and audience. Its success demands advanced skills in responsive and effective relating without the benefit of a previously conceived plan. This reliance on moment-by-moment relation, navigating the constantly shifting configuration of stakeholders, information, objectives, and constraints is intensely demanding, less predictable, and far more creative than pre-scripted project performance. This reliance is also a form of work drawing on feminine capacities. Clearly we do not advocate
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forsaking the scripts of project management – the tools, models, and techniques that serve the profession well. But, despite PMBOK’s silence in this regard, we cannot help but wonder how the profession might look if its metaphors included the innovation of improvisation?

Defining Risk

Definition: “Risk management is the systematic process of identifying, analyzing, and responding to project risk. It includes maximizing the probability and consequences of positive event and minimizing the probability and consequences of adverse events to project objectives.” (PMBOK, 2000, 127)

PMBOK’s definition of risk advocates a preventive and rational treatment to aspects of organizational life that may pose as threats to the successful completion of projects as they are conceived by the project manager and project sponsors. It recognizes that environmental forces can interfere with the implementation of planned projects. And it advocates buffering project work from conflicting influences that can arise from within a project or outside of it.

Handling risks associated with project management is a serious concern to PMBOK’s authors. The chapter on risk is the book’s lengthiest, revealing a strongly masculine orientation to issues of risk. To a project manager informed by a masculine value system, risk is a straightforward concept: that which threatens achievement of predetermined project objectives. In PMBOK’s words, risk is defined as “an uncertain event or condition that, if it occurs, has… a negative effect on a project objective” (p. 127). The profession has evolved extensive and often elaborate tactics to exert control over the unknown. Careful instruction is offered, describing how uncertainties (i.e. risks) ought to be identified, structured, and controlled through various tactics, budgets, and reporting.

Unquestionably, project managers have a responsibility to minimize cost and other inefficiencies, and risk management practices can help to do this. Interestingly, however, what remains unnoted in PMBOK’s discussion of project risk is the reality that, to the degree that project managers execute projects by successfully blocking obstructions or threats to initial planning, they also prevent new information from influencing the project process or desired outcomes: they prevent creativity from entering into the project system. The type of ready, fluid responsiveness known to be a strength of feminine cognition and behaviour takes a different approach to the unplanned events the profession views as risk. Instead of seeing the occurrence of ‘risks’ as exceptional events that ideally should not enter into daily project life, a feminine value system is receptive and interested in such ‘deviations,’ intently seeking a potential only mentioned in passing in PMBOK: “Project risk includes both threats to the project’s objectives and opportunities to improve on those objectives” (our emphasis – p. 127).

DISCUSSION

As a documented and recognized standard of how project managers ought to construct, define, and achieve their success, the PMBOK system provides powerful
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messages about legitimate ways of thinking and behaving to individuals in professional work settings. While no current research evidence proves that PMBOK enhances the perceived success of project managers (Crawford, in press), the book has a wide following.

PMI has taken seriously its stewardship role in promoting the establishment of project management standards. A key element of this role has been codification of its body of knowledge in service of this aim. Codifying a body of knowledge is an ambitious system design task. Necessarily, PMI’s design puts boundaries — gendered boundaries — around those forms of reasoning and behaviour deemed appropriate for the project management professional.

Masculine cognition and action is, perhaps, more amenable to codification, with its clear toward fidelity to normative standards determined at a project’s outset, regardless of the peculiarities of specific situations arising through a project’s life cycle. It is, perhaps, more difficult to document femininity’s relational view of project realities that demand a moment by moment detection and response to subtle and dynamic environmental cues that unfold as a project progresses. The act of documenting a knowledge system, itself, seems to us a masculine-leaning endeavour, favouring a portrayal of project management as faithful performance of appropriate responses through terrain of threatening yet predictable challenges. We consider this system an example of a hazard of any system design, as Ulrich has said, that what gets left out or undervalued are those elements that seem un-neat: “The implicit criterion [for inclusion in a system] is that everything that cannot be controlled or is not known falls outside the boundaries of the model, so that the model itself looks neat and scientific.” His argument, and ours, is that untidiness does not justify exclusion: “Aspects that are not well understood ought to be considered as belonging to the system in question rather than to its environment, at least until their significance has been studied” (Ulrich, 1991, 106-107).

Although PMBOK’s omission is understandable, critical systems theorists would claim it amounts to a failure to exercise responsibility. By implying that PMBOK’s prescriptions are the legitimate way to approach project management, PMI’s PMBOK endeavour fails by suggesting that the book’s approach constitutes the rational way to proceed (Romm, 1996) in managing projects. PMBOK is an inadequate knowledge system as critical systems theorists view adequacy: by making a system’s normative content explicit (Ulrich, 1991). The system design project that resulted in PMBOK was a laudable attempt to increase the success and status of its profession. However, we argue that the result has considerable costs to the psychological health of project managers and to organizations they try to serve. Because its masculine bias is left tacit, project management’s official body of knowledge is particularly damaging.

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5 PMI, the book’s authors, make strong adequacy claims for the book by widely publishing its distribution figures: By 2002, over 939,500 copies of PMBOK (1996 and 2000 versions) were in circulation, and it had been approved as an American National Standard by the American National Standards Institute (www.pmi.org, 2002).
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Jungian scholarship argues that the conscious exploration and development of both masculine and feminine capacities have considerable psychological benefit to individuals (cites). Among such benefits is an intrapersonal bridging function (cite Jung 1957a in our paper) that develops between masculine and feminine reasoning that could permit access to more creativity and problem solving power. Our call for the project management profession to advocate for the use of both gendered ways of reasoning and behaving arises from our concern with the personal, psychological development of project managers as human beings.

However, on its own, such a concern could be dismissed as uncritical emancipation (Gregory, 1996). After all, this is a profession concerned with the successful completion of projects for organizations. Beyond concern for the psychological health and career success of project managers, our call to emancipation should and does aim at improvement of project management itself. A truly systemic way of thinking measures success by its “improvement of the “larger system” (… the population to be served) rather than in terms of… individual careers” (Ulrich, 1996, 166-167). Emancipating the project management profession from overreliance on masculine ways of being and underreliance on feminine ways of being is a worthwhile goal because it will improve the effective managing of projects. Today’s complex projects demand the best of human functioning. Both masculine and feminine strengths have roles to play if project managers are to meet the challenges their projects demand.

Masculinity and femininity are examples of multiple knowledges, which (Schecter, 1991) identifies as a key element in the critical system thinker’s call to action. When two knowledges are present, one tends to be suppressed, rendering its dominant counterpart more greatly legitimized and therefore powerful (Flood and Romm, 1996). Suppression of one knowledge also leaves the other uncritiqued (Schecter, 1991). The matter goes beyond interests in critical reflection. In the case of masculine dominance in a professional knowledge system, when professional behaviour fails to meet organizational demands – which is often the case in this profession (cites) – project managers’ improvement efforts understandably draw on that same masculine focus, the kind of “misguided improvement effort” (Midgley, 1996) that is no improvement at all. Thus, we see project managers seeking to exert increased hierarchical power, dominance over people and processes, control, exercise of hierarchical power, and redoubled efforts to push through perceived project “risks” that deviate from original project specifications (cite our interviews paper). Feminine pursuits of improvement via greater relatedness to a project’s environment and receptivity to changes in that environment fall largely outside the system of practices the profession recommends. (Oliga, 1991) has reported on the danger of one-dimensional uses of power. Given the profession’s official endorsement of a knowledge system dominated by masculinity, such unidimensionality in actual project management practice is understandable, but unfortunate.

RECOMMENDATIONS AND CONCLUSIONS

While the documentation of a body of knowledge may be an important step to establish of a new profession, as (Gregory, 1997) notes, we must remember that such communication is always distorted because it always leaves things out. We suggest that a worthwhile objective for the project management profession would be to make the value
systems that govern PMBOK explicit, focusing on gender inequities in this knowledge system prescribes. The aim of such an effort would be to destabilize the “givenness” (Oliga, 1991) of this body of knowledge as the defining word on professionalism in project management. An outcome of such an effort, we believe, would be the transformation of PMBOK into a more open system, one better able to recognize the contributions that feminine cognition and behaviour do make to the effective management of project-based work – albeit covertly, at present (Thomas and Buckle Henning, in press).

We recommend that PMI treat revisiting the design of its body of knowledge as a project. Heeding (Gregory, 1996)’s advice, this project should be a multiactor one, involving project managers whose success has involved masculine orientations and those whose success has come from feminine strengths. To be a truly critical endeavour, the participation of both gender voices would empower and strengthen the reflective capacities (Brown, 1996) of PMBOK designers’ capacities to voice their thought processes and behaviours in project work, bringing such information into open dialogue. As we have indicated, hearing and incorporating the feminine voice in the design of codified knowledge systems is particularly challenging. The project’s critical objective would be to articulate and broaden the boundaries of recommended project management practice, developing consensus among the two gendered orientations in order to improve the success and continued growth of this important profession. Critical systems theorists have evolved considerable resources in the form of frameworks and questions (i.e. (Ulrich, 1991; 1996; 2005) that can guide the project management revision project.

While the status quo is always a compelling option for any human system, the profession of project management shows signs of interest in critically revisiting its foundational tenets (e.g. (Hodgson and Cicmil, 2006); and the 2006 Special Issue of the International Journal of Project Management (24:8) on “Rethinking Project Management”). Critical systems theorists urge that such critique be viewed as a desire for citizenship: “We ought to support whatever readiness there is on the part of decision makers to think and to act more systemically, and perhaps we can even increase this readiness” (Ulrich, 1996, 167). Boundary critique is a concrete means to move toward increased inclusiveness in project management’s knowledge system, and, we believe, increased responsiveness to the organizational demands project managers face.

REFERENCES


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ABSTRACT

University management implies a great variety of decisions that need to be made in order to maintain financially affordable programs that successfully meet the educational demand and thus achieving a generally understood goal which is that the University works as a self-sustainable system. The Systems Thinking research group (GPS) has developed a variety of projects which main purpose was to use System Dynamics modeling to support University management at Universidad Autónoma de Bucaramanga. A detailed revision of these projects is presented to distinguish common objectives, methods and strategies, organizational learning experiences and along with them, a variety of uses of System dynamics tools that are to be discussed leading towards an extensive reflection about organizational complexities beyond management strategies.

Keywords: System Dynamics, Computer-based Simulations, University Management, Organizational Learning, Systems Thinking.

1. INTRODUCTION

Universities face challenges related to academic affairs, scientific knowledge development, programs quality, market tendencies among others, which make necessary to maintain a continuous learning cycle to check, assess, modify, redesign and restructure policies and procedures in order to meet the national accreditation standards and at the same time to be financially self-sustained. Decision making always involve some level of risk which is always accompanied by high levels of uncertainty. System Dynamics has contributed to support strategic management since the 60’s developing research focused on the use of “learning laboratories” where organization members are able to experiment through simulations without facing the risks of real implementation. “System dynamics is a rigorous modeling method that enables us to build formal computer simulations of complex systems and use them to design more effective policies and organizations”, (Sterman 2000).

Our Research Group1 had been studying System Dynamics methodologies to better understand organizational issues, to explore more effective ways to manage multiple and

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1 Grupo de Investigación en Pensamiento Sistémico. Universidad Autónoma de Bucaramanga.-UNAB. Colombia.
relevant variables and therefore support the complex decision making at a private University in Colombia. Parallel to this purpose, there was a continual interest on developing organizational learning experiences supported by Microworlds which design was meant to promote a systemic view from which it was possible to create causal hypotheses about the organizational structure underlying dynamic behaviors. As a result of these two initial group interests, a variety of research projects were developed in the last ten years. This paper presents the outcomes of a detailed revision of the main research projects focusing on the underlying intentions supporting the different ways to use system dynamics simulations to support organizational learning when dealing with University management strategies.

2. A QUICK GLANCE AT THE RESEARCH PROJECTS

Due to similarities found on the type of documents and the contents developed, a first categorization, based on the purpose of the research, the modeling and simulation uses and the organizational learning experiences, was defined. It is important to clarify that this classification was not necessarily based on a chronological order; instead it was the kind of contribution that each work provides to the Academic and to the System Dynamics community what generated the need to make distinctions among them. The first category included articles written as a result of the studies in System dynamics and the interests related to organizational complexity: “Microworlds: systemic tools towards a innovative strategy for university management” (Cabrera 1997), “A critical revision of Organizational Learning using Systems Dynamics” (Sotaquirá 1996). These articles share a concern toward a systemic comprehension of the way System Dynamics tools are used to facilitate learning among the organization members when facing management related decisions. Back in those first years of research in the group, there was a growing local community interested in studying favorable conditions to encourage learning experiences in organizations as well as developing systemic practices to not just provide innovative and technological solutions to face management challenges, but also to propose genuine ways to approach the problem of University management from a Systems Dynamics perspective. Microworlds, defined by Peter Senge as computer-based microcosms of reality (1990), in which one learns by experimentation, were a visible mechanism intended to facilitate the participation of the organization staff in management related decisions.

The second category included projects developed mainly by undergraduate students on their thesis: Several System Dynamics models or microworlds to support decision making, institutional planning and organizational learning of University departments, both undergraduate and postgraduate programs and other academic and administrative units, like the Research Office for example (Tapias, Torres 1997; Báez, 1999; Báez, Cabrera, Sotaquirá, Rueda 1998; Cabrera, Sarmiento, Serrano 1999, Cabrera, Correa, Peña 1999). As a result of the revision of these projects a common emphasis on building simulation models and appropriate interfaces to interact with the model, was found. The purposes varied with each project but they all share an objective related to a systemic application of system dynamics tools to support organizational learning experiences. The modeling process was focused on the analysis of all the possible variables that could affect the subject matter in each case. The complexity of these models was measured by the amount of selected variables and their diverse nature. Therefore, the user was dealing with a considerable amount of variables represented in causal diagrams that facilitate the comprehension of the relationships among the most significant ones, all those which affected the whole system the most with a slight change. Great part of the research developed on these projects was focused on the identification of feedback cycles that guided the modelers to create multiple scenarios that would ensure the organization to make accurate decisions reducing the uncertainty level. At the same time, the initiative of developing organizational experiences
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was still supporting and guiding the modeling and Microworld design phases. The interest regarding a need to bring together the organization members for active participation was the main purpose of the design of Organizational Learning workshops where they could collectively analyze, assess and design policies and strategies related to available resources management.

During the revision phase it was necessary to define a third category which included thesis and articles written and developed on the basis of an inquiry related to the diverse perceptions of “university” evidenced when facilitating dialogs and discussions during the organizational learning workshops experiences. These inquiries inspired other questions about the ends that supported each perception of the University and that also provided significance to every management decision. Therefore it was apparent that there was a fundamental correlation between management issues and the multiple ends that the organization intent to pursue. Interpretive variety explains how the focal point of the organizational learning experiences needed to aim at the discussion of the ends perceived and understood by the organization members rather than a mere analysis and projection of strategies dealing with available resources (Fuenmayor 2001). At this point, University Management was not only considered a search for the best strategies to manage means to meet an specific end but there was a necessity to guide the organizational discussions toward the disclosure of a multiplicity of existing ends in order to design more coherent strategies and policies leading to them (Gélvez 2005). How was the System Dynamics methodology going to face the new challenge? How could System Dynamics deal with interpretive variety? What fundamental changes needed to be done on the modeling phases? What could be general guidelines for Microworld design to foster an organizational learning that takes into account the multiplicity of ends? The group of articles and projects that intended to answer these questions included: “An evaluation of the possibilities of Systems Dynamics tools for the organizational ends discussion at the University” (Gelvez 2002), “U1, A microworld for University Management (Gélvez 2002), “Microworlds to support the organizational change and decision making processes. A case study with System Dynamics in the University accreditation process” (Gélvez 2002)

3. SYSTEM DYNAMICS USES AND UNIVERSITY MANAGEMENT, A LOOK BACK AND THE FORTHCOMING

As it was presented above, System dynamics simulations have been mainly used as computer-based tools that facilitate management issues directly related to policies assessment and projections which main goal was to support decision making at the University. Mathematical models accuracy reduces the uncertainty of dynamic behaviours always present in organizations when new needs, plans and polices are about to take place. When opening a new academic program, hiring professors, providing the staff professional development opportunities, and in general when possibilities of change and innovation arise, University management ought to focus not only on the means and resources needed to achieve such goals but also, research from the third category group of projects has exposed that there need to be a constant inquiry pertaining to the coherence between the strategies to fulfil the committed plans and the University ends.

In broad terms System dynamics has been limited to handle complexity levels related to variable management and diverse scenario alternatives, which leave aside the intention of unfolding perceptions of University that reflect the societal role that educative institutions should embrace. Other Systems thinking approaches such as The Soft Systems Methodology have considered the influence of worldviews in organizational decisions which has enlighten the road for further studies to comprehend how a system can be
described by different individuals precisely because of the variety of worldviews (Checkland 2000). The third category of projects encourage University managers, System Dynamics and Systems Thinking researchers to take a look beyond the usefulness of means to achieve a particular end that belongs to an individual and opens possibilities to nurture a critical view among the organizational leaders and active members to understand other level complexities that transcend organizational performance and effectiveness as the main goals and rather redirect their attention on social responsibility and awareness. Moreover, the diverse experiences explored through the studies evidenced a tendency to realize that organizational complexity has to do with human action and thus is fundamentally associated to interpretive variety which unity character needs to be revealed, more than management of means responding to the “how”. These insights constitute a theoretical framework from which the University management phenomena must be observed to provide interpretive variety its essential role on the decision making process.

From the organizational point of view, flaws on organizational performance, proactive ineffective strategies that result in just reactive solutions, personal interests interfering with organizational goals, poor performance measurement strategies among others have been the “given” reasons for mismanagement and failing organizational learning practices. This review presents a perspective from which those reasons are not only insufficient but also “non-senses” considering the lack of an organizational and social contexts that provides significance to the human actions in the University. A “Systems Dynamics transcendent”, as it has been called from the third category projects is intended to uncover these contexts which constitute the ground that makes it possible to distinguish meanings to the University ends in order to overcome constant counterproductive results and to create conditions where the essential ends are not misunderstood and are less likely to be reduced to business performance goals.

ACKNOWLEDGMENTS

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REFERENCES


2 This view would be “critical” because it has to unfold the variety of meanings about the social role of the University which remained invisible during these research and organizational learning experiences. In this way the third category of projects can be related to “Critical System Thinking” (Fuenmayor 1990).
University Management using System Dynamics


Gélvez, L. (2002). Microworlds to support the organizational change and decision making processes. A case study with System Dynamics in the University accreditation process.


A SOFT SYSTEMS METHODOLOGY APPROACH TO DESIGN A RESTAURANT MANAGEMENT MODEL FOR A GREAT TOURISM HOTEL

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ABSTRACT
This paper is about the design of a systemic model used in restaurants' management inside the hotels of Great Tourism category in Mexico City, applied to the Restaurant the Gifts of the Hotel Sheraton Centro Historico.

With the purpose of establishing a Holistic vision of the work's development, the use of the Systems' Paradigm and concepts of Soft Systems Methodology by Peter Checkland was determinate, since the case of study is a social system that is not only able to choose means to reach certain goals, but also capable to select and to change them.

The designed model was conceptually defined with the restructuring of the information flows, the reorganization of the restaurant's organizational structure and the view of the elements that affect the system in its intern and external environments.

Keywords: Soft System Methodology, management, restaurant, hotel, tourism.

INTRODUCTION
Tourism is one of the most important and dynamic segments in the current world contributing with around 11% of the world production and generates one of each eleven work positions. It is considered that in next 20 years 1.6 million tourists will travel around the world and they will leave a billion dollars economic spill, in Mexico the tourism sector contributes with over 7% of the national PIB and it also contributes with more than 9% in direct and indirect work positions (Consejo de Promoción Turística, 2006).

Tourism has become a world level alternative to confront the setbacks of the poor countries that look forward to develop alternatives that improve their economies by means of the creation, diffusion and improvement of its tourist destinations, so much of beaches as of cities. Such it is the case of Mexico that occupies the 7º place in tourists' reception at world level with a reception of .31% of the world tourism.

In Mexico the tourist activity and therefore the hotel industry are part of one of the main economic activities, is enough to mention that the hotel occupation constitutes the base to define the tourist demand.

External ambient
The Federal District is one of the most prominent sites of the national territory since it has areas that have been declared as Patrimony of the Humanity by the UNESCO, among which is the Historical Downtown and Xochimilco, considered as a cosmopolitan City that offers cultural and commercial leisure activities, the tourist importance of Mexico City resides in the business segment of tourists of that it receives,
reason why it is a destination that has high occupations in its hotels on week days while the weekends it keeps economic rates and low occupations. Therefore the lodging companies need to establish promotions packages and discounts to the weekend travelers, settled down in the program Dfiesta which is born like an initiative of the DF SECTUR.

The Federal District harbors a series of Great Tourism category hotels that are presented below with the granted category by SECTUR in stars and with the granted category by the American Automobilist Association (AAA) in diamonds.

**Chart 1. Hotels of category Great Tourism of Mexico City**

<table>
<thead>
<tr>
<th>HOTEL</th>
<th>SECTUR CATEGORY</th>
<th>AAA CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARQUIS REFORMA</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>NH TLALNEPANTLA</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>COLON MISIÓN REFORMA</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>ROYAL PEDREGAL</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>SHERATON CENTRO HISTORICO</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>CROWNE PLAZA TLALNEPANTLA LANCASTER</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>J.W. MARRIOTT</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>CAMINO REAL MÉXICO</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>FIESTA AMERICANA GRAND CHAPULTEPEC</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>NIKKO MÉXICO</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>W MEXICO CITY</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>HABITA GT</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>GRAN MELIA MÉXICO REFORMA</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>SHERATON MARIA ISABEL &amp; TOWERS</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>PRESIDENTE INTERCONTINENTAL</td>
<td>GT</td>
<td>◊◊◊◊</td>
</tr>
<tr>
<td>FOUR SEASONS</td>
<td>GT</td>
<td>◊◊◊◊◊</td>
</tr>
</tbody>
</table>

The services provided by the hotels are conformed from the rooms, main source of revenues, until the complementary services such as the restaurant, bar, laundry, dry cleaner's, hairdresser, boutiques, souvenir stores, travel agencies and pharmacy, whose function is to make more comfortable and more pleasant the stay of the guests.
SSM Approach to Design a Restaurant Management Model

On the other hand the hotels with Great Tourism category should have restaurant service inside their facilities as NMX-TT-007-1996-IMNC official regulation establishes (COTENNOTUR, 1996), and should also adopt strict hygiene procedures like the "H" distinctive which specifies the hygienic handling of the food, regulated in the NMX-F-605-NORMEX-2004 norm that along with the operation handling and the use of digital control systems, cause the operation of the restaurant to depend on the very operation of the hotel.

The above-mentioned generates a situation of uncertainty to be able to direct the restaurants, derived from the inability of the executives to determine the strategies of growth, the long term planning and the appropriate production levels to achieve the feasibility of the operations in the restaurant.

At the present time, it is preponderant to create new strategies directed to establish new ways of managing the restaurant establishments inside the hotels that generate management alternatives that correspond to the necessities of the systems, in order to do it is necessary to carry out a diagnose of the current situation to be able to establish improvement mechanisms that contemplate the elements that conform the study object, in this case the “Los Dones” Sheraton Centro Histórico Restaurant that is treated by means of Soft Systems Methodology because it is a system of human activity where the qualitative elements acquire greater relevance to try to know the phenomenon and to promote its improvement, by means of those involved that have common goals but not necessarily search for the improvement of the system.

**Internal environment**

This paperwork approaches the problem and proposes a model of restaurant management for a great tourism hotel of Mexico City that considers the limitations settled down by the international frame mark policies and the tendencies of the tourism, to contribute to the decisions making and its improvement.

The administration involves the decisions making inside the management, which is composed by the head master committee whose main functions are constituted by: specify the orientations, to suggest the development of the actions, to favor the exchange of information, to deal with the conflictive issues and to take actions.

Below the departmental divisions of the Hotel Sheraton Centro Histórico are presented with the intention of locating the department of Food and Beverages that will be studied along the analysis.

![Figure 1. Departmental Divisions of Hotel Sheraton Centro Histórico Mexico City](image_url)
SSM Approach to Design a Restaurant Management Model

For the specific case to be studied the Hotel Sheraton Centro Histórico is composed by the division by departments.

Inside the attributions of the Food & Beverages (F&B) department, the informative hierarchical flow that composes it, is presented next.

![Organisational Chart](image)

**Figure 2. Food and Beverages department Organisational Chart**

*Source: F & B Policies and Procedures Hotel Sheraton Centro Histórico Manual*

Inside this representation, we can observe not only the hierarchy lines but the representation of the information flow by means of the which the communication channels that give life to the restaurant system are established, composed by the Food and Beverages area that is divided in two specific areas: on one hand the kitchen area or production of food and for the other one the management of the services area.

This kind of structural hierarchy is designed to allow the free flow of information for the decisions making, however, the restaurant is divided inside its management by the areas so much productive as for the services areas, maybe for a convenience in the handling of the Food and Beverages in general. That when being examined from the systems approach shows us the inconsistencies of the hierarchical structure, because work cells are not being integrated under a communicative hierarchy capable to carry out functions that regulate the disorder in the system, which generates a lack of functionality in the handling of the management.

It is necessary to mention that the hotel restaurant system belongs to an specifically greater area, a greater system denominated Food and Beverages by means of which, a centralized management is carried out to control the information flows and the management handling, concentrating it on the section chief of the Food and Beverages area named: Food and Beverages Head Master.

Generally, the hotels have an area manager, this person has the attribution to control the operation, we refer to the restaurant captains, whom have under their responsibility to control and to coordinate the physical operation of the establishment, is important to mention that inside the management patterns of the hotels, it is considered that management or management committee is considered as the only one authorized to carry out modifications, proposals or adaptations to the operation systems, although they are not directly controlling the operation of the area. This means that although it is certain that a high hierarchy is necessary to make certain decisions, it is also certain that the operation, organization and planning for the right decisions making to improve their own management, should be left in the hands of the direct area managers.
SSM Approach to Design a Restaurant Management Model

The same thing happens within the information flows since generally, the head masters receive all the information that concerns to the decisions making, and they take their actions establishing a general level of management in the whole area of food and beverages. That is to say, they consider non appropriate solutions for particular F and B consuming centers because they visualize all of them as homogeneous.

The above-mentioned is considered as a non functional element of hierarchical competence, on the other hand it is convenient to mention that the information received by head masters is processed by the Food and Beverages management establishing the necessary presage that cover its required level of economic and sales benefit, without considering or carrying out an analysis of the situation that consuming centers live at the moment where their area managers are far from being decisions makers and only assume a technical role, controlling the physical operation and giving solution to the problems that are generated during the day.

On the other hand, the headmasters generally are not appropriately prepared to establish tools or instruments that allow them to measure the way in which the actions are developed inside the restaurants in a qualitative way. They consider the sales like only element that indicates everything goes like it should, when the necessary thing to improve their managerial levels is to consider the qualitative and quantitative variables that generate an improvement in the sales variable.

Inside the current management that the hotel restaurants follow and in general in the whole hotel, complaints and technical handlings and abilities that the supervising personnel have to control such complaints are given priority. However, they are only centered in the possible solutions that can generate a favourable situation in the moment of the quarrel with the client, without taking in consideration the primary causes that caused the phenomenon, generally the bad service it is solved with granting incentives to the clients like discounts, special prices or simply the reinstatement of the physical product that constitutes the service, in this case the dishes of the restaurant that generates higher costs but doesn't solve the frequent problems to which the services providers face.

Inside the quality controls with which the Starwood chain counts, we can find the inspection visits of the corporate to measure what they call the quality of the services, which rather refer to the execution of the standards to determine the perseverance in their use. This revision is performed every 6 months and at the end of the inspection the executive committee meets with the Shopper, who informs on the obtained results.

This kind of evaluations is very common inside the hotel industry where the handling of the standards is related with the client's satisfaction, trying to establish a level of service, that is to say that the quality of the service is reduced to the repetitive use of standards, minimizing to a very inferior scale the human potentialities that can be directed toward better structured goals.

The above-mentioned, shows one more lack of functionality in the evaluation aspect of the services providing.

Is important to mention that the lack of functionality presented in this stage of the research will be recaptured for the structuring of the restaurant management model in which they will be given a systemic treatment to promote their improvement.
SSM Approach to Design a Restaurant Management Model

DEVELOPMENT

The systems of human activity are systems models built to perform an activity with the intention of questioning the situation of the real world in a comparison phase. Contrary to the hard systems, the human activity systems or soft systems face disordered problems and human beings in social roles, reason why the methodology is used to create the Holón (the whole) with defined purpose and emergent property that is to say with capacity to pursue the purpose completely (Checkland & Scholes, 1994).

Description of the not structured problem

Next, through the use of the soft systems methodology is presented the first image that makes allusion to the situation in which the problem is perceived.

In this stage, it is necessary that the researcher knows the nature in which the problematic situation is generated. Based on the theoretical information analyzed and on the experience about the Hotels systems, the definition of the studied system is presented next.

Figure 3. Definition of the studied system
SSM Approach to Design a Restaurant Management Model

*Interpretations*

The previous graph shows us the elements that intervene in the Restaurant Management Model for a Great tourism Hotel inside Mexico City where, in a first approach, we can notice the existing relationship between the elements and the environment to consider.

Inside the previous relationships, we can notice that the regulations imposed by the STARWOOD Chain, acquire higher relevance since they are constituted by the standards, policies and procedures of the brand, generated in the corporate that establishes the requirements inside which the operation of the Great Tourism Hotel Sheraton system is held.

On the other hand, the System doesn't escape the classifications of international organisms that establish a series of regulations, in this case we refer to the OMT, that generates information and supports toward the sector.

The regulations imposed by the federal governments that vary depending on the locations in which the hotels are, run in charge of Federal Tourism Ministry (SECTUR) main promoter of the destinations and their development.

Inside the local area the regulations run in charge of the Federal District Government and specifically in this case, with the Mexico City Tourism Ministry (SECTUR), inside their attributions and competences.

On the other hand, the recipient community is constituted by the necessary human capital for the operation of the system that performs a primordial role inside the development of the services.

Inside the considerations of the environment, we find the regulations, supports, information and training provided by the National Association of Hotels and Motels (ANHM), which is born with the intention of giving support, impulse and development to the Hotel companies of the country.

On the other hand, we have the settled policies by the American Automobilist Association (AAA) in charge of establishing the criteria to categorize the services as well as the facilities provided by the deluxe hotels, to locate them inside some category identified by the number of diamonds that it grants.

In the centre of the image we have the representation of the Restaurant Management Model inside the Great Tourism Hotel of Mexico City where the mainly involved are in the central part of the model represented by the decision makers head master executives and the services direct providers, the collaborators or employees of the hotel that provide the services to the customers.

For the present study, an investigation instrument was designed by means of which direct interviews directed to those involved were carried out, which gave us the interpretations of those involved and that were used for the design of the Restaurant Management Model inside the Hotel Sheraton Centro Histórico of Mexico City:

*Situation of the Expressed Problem*

Inside the expressed situation the situation of the problem was developed through enriched graphs that are the means to capture as much information as possible. An enriched graph shows the human system behind the activity, and in addition, it indicates us anomalies and how the structures and the processes are related to each other.
SSM Approach to Design a Restaurant Management Model

Root definition of the relevant systems

The enriched graphs helped to express the main problems of the situation, which are going to be solved by root definitions of the conceptual systems to be proposed. For example, the six elements of root definitions are presented in the initials CATWOE where the necessary minimum activities are required to solve the anomalies, are described in the human activity system under study.

C= Customers- They are those that are benefited with the system under studied, for example:
1. Hosts
2. Tourist Market (Travel Agencies)
3. Employees
4. Other Hotels
5. Local Population

A= Actors, are those who will be in charge of the transformation of the information entrances into exits. STARWOOD Policies and Procedures.
1. SECTUR
2. Managers
3. Employees

T= Transformation. Is the process of the entrance conversion into exit.

Figure 6. Transformation Diagram
Weltanschaung. - Is the German expression for the vision of the world, this vision of the world makes the transformation process meaningful in the context, in this stage we recapture the results of the applied instrument and synthesizing is presented in the following chart.

<table>
<thead>
<tr>
<th>ACTORS</th>
<th>POSITIVE VISION</th>
<th>NEGATIVE VISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starwood Brand Policies.</td>
<td>They allow the control of the standards</td>
<td>They limit the creativity and they reduce the initiative of the human factor.</td>
</tr>
<tr>
<td></td>
<td>They propitiate the understanding of the tasks to develop.</td>
<td>Create insensitivity when treating people they motivate impersonalized service.</td>
</tr>
<tr>
<td>Management Performance</td>
<td>Propitiate the development inside the company.</td>
<td>They propitiate a difficult atmosphere when establishing progressive discipline</td>
</tr>
<tr>
<td></td>
<td>They perform integration and motivation functions of personnel.</td>
<td>to maintain the control of the actions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>They don’t solve the generated inter departmental conflicts in benefit of the</td>
</tr>
<tr>
<td>Kitchen area</td>
<td>Promotes standardized times.</td>
<td>services.</td>
</tr>
<tr>
<td></td>
<td>Accomplish, within possible, the customers requirements.</td>
<td></td>
</tr>
<tr>
<td>Steward Department</td>
<td>They keep an adequate stock in each area that allows the good operation of</td>
<td>They propitiate scarcity of equipment when transferring it to other consuming</td>
</tr>
<tr>
<td></td>
<td>service.</td>
<td>centers.</td>
</tr>
<tr>
<td></td>
<td>They promote the separation of the equipment by size and shape to speed up</td>
<td>In saturation moments they propitiate delays in the delivery of the equipment.</td>
</tr>
<tr>
<td></td>
<td>its cleaning.</td>
<td></td>
</tr>
<tr>
<td>Bar Area</td>
<td>Maintains updated inventory.</td>
<td>They forget to Publish their Products in 86.</td>
</tr>
<tr>
<td></td>
<td>Provides a quick answer to the customers needs.</td>
<td>The supply process of warehouse y too lingering.</td>
</tr>
</tbody>
</table>
SSM Approach to Design a Restaurant Management Model

O= The owner, the decisions maker that in this case is the General Director and owner of the Hotel Mr. Siau Sitton, through his faculty as direct Head Master of the Hotel and in his majority investor role.

E= Environment

That is composed of the following elements.

- The policies and procedures of the Starwood Brand
- The Tourism Ministry in its ruler and regulating faculty.
- The Mexico City Tourism Ministry in its faculty to grant the operation authorizations.
- The norms emitted by the OMT in their ability to influence in the world corporations.
- The AAA within its faculty to grant the recognitions of services and facilities levels, measured with diamonds.

The Root definitions allowed examining the policy of the problematic situation and as the power is obtained and used, since a Root definition is a condensed representation of the system in its more fundamental form.

Inside this stage, we proceeded to the construction of the conceptual models starting from the root definitions, these models present the necessary minimum activities to develop the process of the system where one of the activities is taken like a resource of the new root definition which is modeled with more detail. The model looks for to raise the human activity and it denotes the relationships of the different elements with the environment.

Inside the following diagram the correlations of the subsystems that integrate the Conceptual Model System of restaurant management for a Great Tourism Hotel of Mexico City are presented:
Comparison of the real world with the considerations of the real world systems.

The Hotel Sheraton Centro Histórico operates with the following human systems, a decisions maker human system compound by head masters and managers, in which the managerial planning converges, on the other hand the operative Human System made up of the personnel of customer direct services personnel, responsible for the customers satisfaction and for a system called human support System, composed by personnel from support to the production, constituted by the personnel that doesn't provide services directly to the customers but that however perform support tasks.
Feasible changes and actions to improve the situation

The formality of the scientific research implies the measure of the concepts that intervene in its development, the simplest measure concept is constituted by the comparison, to perform it, the proposed model’s systems became operative, in order to verify its boundaries, comparing them with the accomplishment current operating systems.

According to the situation of the relevant systems, the actions that transformed the reality of the system are presented next, because the systemic approach is not only useful to know the existent reality but also to transform it.

Political and mark procedures

The brand policies should respond to the necessities of the system, that is to say that they should be planned and elaborated to respond to the necessities of the elements and the relationships that compose the system, therefore they should be flexible and adjustable. The system is in constant evolution generated by the internal and external elements that mark the different states in which the system is through time where such flexibility can be considered to perform an appropriate evaluation.

Performance Evaluation

Inside the performance evaluation of “Los Dones” restaurant, it is proposed the implementation of a tool of its own that provides information about the customers’ satisfactions, with the intention of being able to adjust the policies and procedures, directing them toward the necessities of the customers.

Organizational structure

Inside the current organizational structure a series of errors derived from the administration are propitiated, they are enunciated in the analysis of the diagnosis, reason why an organic structure able to be adapted to the necessities of the subsystem restaurant is proposed.

Inside the hierarchical environment the proposal is directed toward the adjustment of the structure in such a way that allows a greater fluency in the information and agility in the decisions making. The proposal is viable because it is a hotel of franchise of the Sheraton brand for such a reason a structural change it is promoted in the operation of the restaurant that allows it to work as a productive system, eliminating the barriers of communications and improving its management.

Taking in consideration that it belongs to a bigger system the proposed changes are recommended only for the restaurant, being the management of Foods and Beverages intact for a feasibility matter, which means that an improvement is intended in the restaurant area without compromising costs or unnecessary expenses trying to change the organic structure of the Hotel.

Next, the related proposal is presented, toward the organizational structure of the “Los Dones” restaurant.
The proposed Flowchart tries to break the barriers of the traditional communicative and hierarchical bureaucracy that hotels pursue where a control and leadership attribute is created in the restaurant manager, to whom will be given attributions to handle the management of its domain without breaking the informative link with the restaurants and bars neither with the Food and Beverages head master. The same thing happens in the case of the kitchen where the existent hierarchical link with the executive Cheff is recognized, however with the proposal a work cell is created where the restaurant manager has the faculty to take to the subsystem restaurant to execution of the objectives.

*Restaurant management Personal*

In this case the proposal is directed toward specialized personnel's recruiting, mainly in the part of the restaurant management because operative technical personnel is usually hired to carry out this functions, when the most convenient, in the case of the new organizational structure of the restaurant, is to have specialized personnel able to give answer so much to the technical as to the administrative and growth matters.

*Human capital development*

For this improvement proposal it is considered the development inside the organization as well as the human development, that is to say that the personnel should be developed in both areas to be able to be functional to the long term directed proposals. This means to break up with the hotel tradition of the internal development to be able to integrate it to the human personal development, remembering that only the authenticity of the services actions is considered as valid within its providing, therefore there should exist a link with the educational institutions that supply of the required human factor.

The model feeds back through the training of the employees and the formation of the tourist sector professionals where the main involved are so much the department of human development as for the educational institutions.

In a pictorial way the previous reflections are shown next:

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**Figure 8. Proposal of organizational structure for the “Los Dones” restaurant.**
CONCLUSIONS

The globalization is a nowadays phenomenon in the big transnational companies, airlines, hotels and shipping that look forward to be more and more competitive every time with the intention of obtaining differential advantages that distinguish them from their competitors, phenomenon that is difficult if we consider the vertiginous changes in the information systems generated by the new digital electronic era that has transformed the way of operating, of serving, of providing, and merchandising the tourist services. Reason why these companies are forced to establish criteria, standards, policies and procedures that can derive in the approach toward customers’ satisfaction.

The new ways of managing are born from the necessity to improve the managerial profitability that has generated new handling models, control and application of the resources that taken to the tourist plane, increase their complexity because they are centered in the handling, control and development of the human resources so much operative as administrative who are those responsible for the customers’ satisfaction.

The restaurant management model of a Great Tourism hotel dismembers the components that integrate it with the intention of carrying out the analysis that lead us to identify the vulnerabilities that the lodging companies suffer when being subjected to the soft systems methodology, because they are centred in policies and brand procedures designed to increase its profitability without it necessarily deriving in an increment of the satisfactory level experienced by its customers.

When being subjected the study phenomenon hotel restaurant to the systemic methodology, the divisional operation of the involved departments was demonstrated, because the restaurant is composed of a series of departmental jointing that respond to different hierarchical lines and therefore to diverse lines of information.
SSM Approach to Design a Restaurant Management Model

However, the main lack of functionality finds is found in managerial levels, from medium and higher management where the priority is the technical operability of the areas assigned to such positions, without being able to be centred in the planned strategic development that can take the organization to an evolution and to the joining of the generated changes in its environment that can reduce the uncertainty that it experiences.

The previous work represents an effort to analyze and to improve the tourist companies that for the fact of belonging to a complex sector are also complex, as a consequence they require to be treated from global knowledge generating perspectives that can lead to positive results, because, although it is certain that it is developed in technological levels, its importance resides since in the healthy managerial handling of the human resources since it is the only road that allows it to be developed.

Therefore, new organizational outlines that centre their attention in the necessities and the clients' requirements are required, so it turns out imminent, at least in the hotel tourist sector, not only to train the human resources but it is also necessary to allow their professional and human development that derives in genuine interactions able to transform the perceptions of the customers that in turn are translated into greater economic benefits.

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REFERENCES


Further reading


BEING VALUES AND BENEFICENT OBSESSIONS: APPLYING THEORIES FROM MASLOW AND ASSAGIOLI TO EVOLUTIONARY GUIDANCE MEDIA

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ABSTRACT
Memes are units of cultural information, the symbols that shape our worldview. In seeking to create a sustainable worldview we require memes, i.e., words, images, and systems, capable of serving as evolutionary guides for societies at varying levels of development. The evolutionary guidance systems framework designed by Bela H. Banathy is one such societal meme. Its application to media resulted in evolutionary guidance media, a framework for creating media designed to promote planetary consciousness. In continuing the design of evolutionary guidance media, this paper explores the application of Maslow’s theory of “metapathologies” as a means of isolating and/or diagnosing societal ills, and examines the use of “being values” as antidotes. To expedite the healing process Assagioli’s “technique of evocative words” and the “beneficent obsession” are presented.

Keywords: social systems design; evolutionary development; evolutionary guidance systems; media, transpersonal studies; humanistic psychology; positive psychology

EVOLUTIONARY GUIDANCE MEDIA
As systemists, we investigate synergistic interactions, whether among/between atoms, cells, and organs, or family units, communities, and institutions. Indeed the investigation of such interactions is considered to be the defining characteristic of systems science (Laszlo, 2001). Although many of the interactions systemists investigate seemingly take place effortlessly, in looking at human interactions, specifically at the societal level, it is easy to feel disheartened - often our interactions resemble that of a species hell bent on obliterating, not only itself, but the very matrix within which it survives. Global warming, brought on by human actions and interactions with the natural world, is but one current example.

In an effort to find ways and means to facilitate and promote more sustainable and peaceful interactions between human beings, systemists set about designing evolutionary guidance systems (EGS) - systems that actually guide the development of human systems such that the systems created are able to encourage the holistic development of both individuals and their systems (Banathy, 1996). EGS are capable of being applied at the micro level, to the for example family unit, or the macro level, e.g., the societal. Through applying the EGS framework to media, a system designed to facilitate the creation of conscious media, or evolutionary guidance media (EGM) was birthed (Klisanin, 2003, 2005, 2007). Application of the EGS framework to media was perceived to be particularly relevant due to the central role media plays in creating and transmitting units of cultural information, or memes (Dawkins, 1978). In order to facilitate peaceful planetary co-existence, memes, i.e., words, images, and systems, are required that are capable of serving as evolutionary guides for societies at varying levels of development. EGM was created with that purpose in mind. In short, EGM is media designed both in context and content for the purpose of guiding and/or facilitating the societal emergence of transpersonal consciousness, specifically planetary consciousness.

Following Banathy’s lead, the EGM framework was designed utilizing nine interactive dimensions of human activity, including “social action, economic, moral, wellness, design, scientific, technological, aesthetic, and political” (1996, pp. 324-325). The interactive nature
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of the dimensions encourage synergistic unfolding, often revealing new directions for research and/or valuable insights, for example, in earlier research a merger between the moral and technological dimensions resulted in the concept of transception, a term coined to refer to cyberseption infused with qualities of high spiritual development, such as compassion (Klisanin, 2005).

This paper focuses on exploring data arising from both the wellness and aesthetic dimensions while utilizing data previously allocated to the moral dimension (i.e., Being values). In the generic EGS framework the wellness dimension exists to “nurture the physical, mental, emotional, and spiritual health and well-being of the individual and society,” while the aesthetic dimension represents “the pursuit of beauty, cultural and spiritual values, the various forms of art, the treasures of humanities, and the enrichment of our inner quality of life” (Banathy, 1996, pp. 324-325). As applied to EGM, goals of the wellness dimension include promoting integral practices and avenues of interpersonal contact, while goals of the aesthetic dimension include utilizing subjects of visionary art and metaphors of consciousness (Klisanin, 2003). Three approaches to inquiry (outside of systems science) have been and continue to be particularly important to on-going research in EGM; these include the humanistic, transpersonal, and integral approaches. In this exploration, the following constructs, arising from the humanistic and transpersonal disciplines are examined: Maslow’s construct of “Being values” and “metapathologies” (1968, 1971) and Assagioli’s concept of the “technique of evocative words” and the “beneficent obsession” (1970).

Maslow’s Construct of Being-values and Metapathologies

Maslow’s (1968) theory of development is a holistic process based on motivation, exemplified by his well-known “hierarchy of needs” pyramid in which basic needs, such as food and shelter must be met before attention can turn to meeting other needs, such as love and belonging. In the course of his research, Maslow found that the presence of certain universal qualities, traits, and/or values, were necessary for people to successfully cross from the level of self-esteem to that of self-actualization (i.e., the apex of the pyramid, considered to be a dynamic on-going process of integration). He coined the term Being values, or B-values, to refer to those specific qualities, traits and/or values, and included among them: truth, goodness, beauty, wholeness, aliveness, uniqueness, perfection, completion, justice, order, simplicity, richness, effortlessness, playfulness, and self-sufficiency (Maslow, 1968, pp. 133-135).

In addition to finding the presence of B-values necessary for movement into self-actualization, Maslow found that the absence of B-values led to the creation of specific metapathologies; for example: the absence of truth led to disbelief, mistrust, cynicism, scepticism, and suspicion, while the absence of simplicity led to overcomplexity, confusion, bewilderment, conflict, and loss of orientation. While providing an incomplete summary, the following table offers further examples.

Table 1. Being Values and Specific Metapathologies (excerpted from Maslow’s table 1971, p. 318)

<table>
<thead>
<tr>
<th>B-values</th>
<th>Specific Metapathologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truth</td>
<td>Disbelief; mistrust; cynicism; scepticism</td>
</tr>
<tr>
<td>Goodness</td>
<td>Utter selfishness; hatred; repulsion; disgust</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Beauty</th>
<th>Vulgarity; loss of taste; fatigue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unity, Wholeness</td>
<td>Disintegration; arbitrariness</td>
</tr>
<tr>
<td>Aliveness</td>
<td>Deadness; robotizing; loss of emotion</td>
</tr>
<tr>
<td>Uniqueness</td>
<td>Loss of feeling of self and individuality</td>
</tr>
<tr>
<td>Perfection</td>
<td>Discouragement; hopelessness</td>
</tr>
<tr>
<td>Completion</td>
<td>Feeling of incompleteness; cessation of striving or coping</td>
</tr>
<tr>
<td>Justice</td>
<td>Insecurity; anger; mistrust; total selfishness</td>
</tr>
<tr>
<td>Order</td>
<td>Insecurity; wariness; loss of safety</td>
</tr>
<tr>
<td>Simplicity</td>
<td>Overcomplexity; confusion; bewilderment</td>
</tr>
<tr>
<td>Richness, Totality</td>
<td>Depression; uneasiness; loss of interest in the world</td>
</tr>
<tr>
<td>Effortlessness</td>
<td>Fatigue; strain; striving; clumsiness</td>
</tr>
<tr>
<td>Playfulness</td>
<td>Grimness; paranoid humorlessness</td>
</tr>
<tr>
<td>Self-sufficiency</td>
<td>Dependence</td>
</tr>
<tr>
<td>Meaningfulness</td>
<td>Meaninglessness; despair; senselessness of life</td>
</tr>
</tbody>
</table>

**Assagioli’s Technique of Evocative Words**

In a monograph entitled “The Technique of Evocative Words,” Roberto Assagioli (1970), an Italian psychiatrist and the pioneer of psychosynthesis, outlined a method of acting on the psyche to modify behaviour, or attitudes. For purposes of psychological development, integration, and transformation he suggested that a specific word be chosen representing a desired quality (e.g., patience) and then be written on a card and placed where it could be easily noticed. He suggested that a stronger effect could be obtained by placing several cards with the same word in multiple places and rooms, referring to the latter as a “beneficent obsession” (1970, p. 2). He specified the following words, while noting that others could be added as desired: calm, joy, comprehension, love, confidence, patience, courage, serenity, energy, silence, enthusiasm, simplicity, goodness, will, gratitude, wisdom, and harmony (1970, p. 4).

Assagioli (1970) went on to qualify the use of words as the most basic method of persuasion, referring to the techniques used by the advertising industry as yet more sophisticated means, (e.g., the use of displays and posters; suggestive phrases and slogans; persuasive and fascinating pictures; persistent repetition of name, theme, or slogan; musical themes; and rhythmic movement, gestures, and dances). He mentioned Farhad Hormozi,
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(1970) an advertising executive who at that time had proposed that desirable qualities and socially healthy attitudes be promoted by incorporating techniques common to his field. Indeed, Hormozi went on to create one of the first campaigns demonstrating the idea in action (1987).

Assagioli suggested that such techniques be applied not only to foster integral self-actualization and realization in individuals, but that they could be utilized in education, as a foci of concentration, psychological conditioning (e.g., preparing for a competition), and psychotherapeutic applications (e.g., in hospital rooms and offices). However, he pointed out that in some instances the technique of evocative words might elicit negative reactions, particularly in those who may have a lack of such qualities, in which case he suggested other forms of psychotherapy.

Application to Evolutionary Guidance Media

Maslow’s constructs of metapathologies and B-values, and Assagioli’s technique of evocative words and the beneficent obsession, have their origins in the humanistic and transpersonal psychological traditions, both of which hold that individuals have the capacity to evolve. EGM creators may find those constructs helpful as points of departure in their quests to create media designed to promote planetary consciousness. Although EGM creators are not therapists, through simply being aware of the relationship between B-values and metapathologies, a new level of awareness is brought into play when examining the needs of communities and the world-at-large. Likewise, one need not be a therapist to appreciate the potential of using B-values, and evocative words to simulate positive development, however familiarity with an Integral model (e.g., AQAL) would be helpful (i.e., memes created to appeal to persons at the egocentric, or ethnocentric levels of ethical development may not be appealing to those at the worldcenter level, and so forth) (Wilber, 1995, 2000). Recall that in Maslow’s developmental model, it was a lack of movement, or growth, from the level of self-esteem needs to that of self-actualization that brought attention to the important role of B-values in furthering human development.

While truth, simplicity, and meaningfulness are general terms, they are laden with symbolism. As such, when considered as guiding themes, they have the potential to simulate and facilitate the creative process. Many have been the subjects of visionary art (e.g., beauty, love, truth) as well as metaphors of consciousness (e.g., unity, wholeness, wisdom) in cultures around the world, and as such they complement the aesthetic dimension.

Addressing the wellness dimension, an EGM creator might, for example, research various B-values across cultures, and create hybrid memes -- words, images, stories, music, films, videogames -- capable of serving as bridges, facilitating understanding and cooperation between people of various nationalities, ethnicities, spiritual traditions and so forth. A historical example of such an attempt can be seen in Hormozi’s (1987) work. Noting that musical notations, mathematics symbols, trademarks and logos, were the same around the world, he posited creating a symbolic language to express human qualities, and to that end, commissioned the British graphic designer Tom Eckersley to demonstrate one style, seen in Figure 1.
In the years since Maslow and Assagioli conducted their pioneering research, investigations in the area of human values, qualities, and traits have flourished. Today the results of such research is nowhere more evident that in the field of Positive Psychology. A seminal handbook in that field, *Character Strengths and Virtues* (Peterson and Seligman, 2004) identifies six classes of core virtues (including: wisdom and knowledge; courage; humanity; justice; temperance; transcendence) and twenty-four character strengths. The on-going research in this field should prove to be an important source of material for EGM creators.

While it is true, for the part, that media designed with intensity of style and scope is often aimed at inducing the consumer to purchase and consume, there are notable exceptions, including campaigns by non-profit organizations designed solely to effect positive change in the world. Examples include: the Natural Resources Defense Council (2008), dedicated to preserving and protecting the natural world; The Foundation for a Better Life (2008), dedicated to creating public service campaigns modelling the benefits of a life lived with positive values, and the pioneering Ad Council (2008) dedicated to creating and distributing public service advertising campaigns designed to effect positive change. Each of these organizations serve as valuable models for media creators seeking to promote planetary consciousness, particularly as each have interactive components inviting participatory action (via websites and links to other organizations).

The proliferation of personal computers, laptops, and cellular phones equipped with Internet connectivity has provided media creators with opportunities to see the memes they create span the globe in mere seconds. One particularly fertile area where EGM creators might venture (with B-values on their palettes) is that of videogames. Bogost (2007) has argued that video games, due to their representational mode of procedurality (i.e., rule-based representations and interactions) represent a new form of rhetoric, i.e., “procedural rhetoric,” and as such, a new form of persuasion (2007, p.ix). He suggests that videogames can be designed that support existing social and cultural norms, or that change those norms.
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Although many videogames are geared towards the solo player, many others are played on-line by multiple players simultaneously. The on-line gaming market is one of “synthetic worlds” where millions of people choose to spend enormous quantities of time (Castronova, 2005, p. 4). Videogames and synthetic worlds both offer promising venues for media creators seeking to impact the world through their creations. (Note: investigating such areas brings the technological dimension front and centre, demonstrating the fluid or porous nature of the EGS model.)

In summary, EGM creators familiar with the pioneering works of Maslow and Assagioli, as well as current research in the field of Positive Psychology, will find much to take into account when creating consciousness-raising media. By skillfully blending data from the wellness dimension, the aesthetic dimension, and the technological dimension they may yet give new meaning to the term, beneficent obsession … and in doing so, make Assagioli and his pioneering counterparts proud.

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BUSINESS MODELS AND EVOLVING ECONOMIC PARADIGMS: A SYSTEMS SCIENCE APPROACH

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ABSTRACT
For professionals at the beginning of the 21st century, much of the conventional wisdom on business management and engineering is founded in the 20th century industrial / manufacturing paradigm. In developed economies, however, the service sector now dominates the manufacturing sector, just as manufacturing prevailed over the agricultural sector after the industrial revolution. Simultaneously, as end products have transitioned from material outputs to information in digital form, traditional business models are under siege. The economic sociology in this new world challenges the integrity of models, methods and interventions successful in an earlier paradigm.

Since 2005, IBM has encouraged universities to develop a new field of Services Science, Management and Engineering (SSME). Researchers are responding with development of a new science of service systems, but mature foundations will require years of collaboration. In the absence of a well-established science from which educational curricula can be deduced, teachers can develop educational programs for joint learning, guided inductively by relevance and pragmatism.

A new seminar on business models – ways in which business organizations operate and evolve – is proposed. Complementing traditional management and/or engineering curricula, this course challenges students to reconsider contexts, surface assumptions and explore alternative approaches to business. With a domain that includes both human and technological parts, systems science serves as a skeleton on which content can be structured.

Keywords: service science, systems science, business models, economic paradigms

1. INTRODUCTION: WHAT CAN ENGINEERING AND MANAGEMENT STUDENTS LEARN AS A NEW SCIENCE EMERGES?
Since a National Academy of Engineering report was interpreted as a “failing grade for the innovation academy” for not meeting the needs of service businesses (Chesbrough 2004), IBM has encouraged the development of a body of knowledge on Service Science,
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Management and Education (SSME). This has led to some formalization as steps towards a science of service systems (Spoher, Maglio et al. 2007), and a definition:

A service system can be defined as a dynamic configuration of resources (people, technology, organisations and shared information) that creates and delivers value between the provider and the customer through service. In many cases, a service system is a complex system in that configurations of resources interact in a non-linear way. Primary interactions take place at the interface between the provider and the customer. However, with the advent of ICT, customer-to-customer and supplier-to-supplier interactions have also become prevalent. These complex interactions create a system whose behaviour is difficult to explain and predict. (IfM and IBM, 2008, p. 6)

Initial approaches to the engineering and management of service systems have built incrementally on existing disciplines. The disciplines include economics and law, operations research, industrial engineering, computer science, information systems, MBA and management consulting, management information systems and knowledge management, organizational studies and organizational learning (Spoher, Maglio et al. 2008, pp. 6-7). Curriculum has been developed as courses inserted into existing programs (IBM 2006) and as the premise for a new program (Tukiainen, Takala & Ing 2006). While a new science of service systems is under development, a bottom-up approach to curriculum development has been practical.

As a complementary contribution to an educational curriculum, this paper proposes a seminar that embraces uncertainties as the science of service systems evolves. A course on business models – the way that businesses operate from a systems perspective – is targeted at graduate-level students in management and engineering. The challenge of multi-disciplinary thinking is dissolved through a foundation in systems science. Since much of our current thinking on services is anchored in industrial age management and engineering knowledge, an agricultural paradigm is added as an irritant to provoke deeper thinking.

The next section describes approaching an understanding of changes in the business world with technologies enabling and driving reflection of historical views of economies. As a path to structure discussions on features of the changes, an outline of topics selected from concepts in systems science is proposed. As a concrete demonstration of an alternative perspective, a reference framework of business models is described – not as an end point, but as a platform for conversation. The paper concludes with a discussion on pedagogy as a Singerian inquiring system, appropriate for the new body of knowledge on service systems emerging from multidisciplinary foundations.
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2. CHANGES IN THE BUSINESS WORLD ARE BETTER APPRECIATED FROM AN OUTSIDE PERSPECTIVE

“It’s like the fish in water. We don’t know who discovered water but we know it wasn’t a fish. A pervasive medium is always beyond perception.” - Marshall McLuhan

Establishing new perspectives on engineering and management as a new science of service systems emerges presents a legacy challenge. Current practices, experience and education are anchored on sciences with a long history of development over the past half century. We bring predispositions and assumptions from an era that may or may not continue to be valid. As an example, how should we measure business performance? Many service businesses count hours of labour (e.g. billable utilization) as a key measure of productivity. Service businesses centered on expertise and skills often find that measurement logic can encourage to dysfunctional behaviours. Profitability and the quality of customer deliverables are not always improved by more working hours. While looking forward in time to plan absences precludes wasting resources, recording and reviewing hours worked and not worked (e.g. vacation) adds administrative overhead unnecessary to the senior business professionals (Belson 2007). Counting hours in a service business may be as nonsensical as a standard 9-to-5 schedule to a farmer who tends to fields and livestock from sunrise to sunset.

In the section that follows, challenges in understanding the “new” economy with definitions from the “old” economy are reviewed. Then, systems science is proposed as a common point of reference for both engineering and management education. Advances in technology are posed as a primary driver changing the economics of a business. Business models are then proposed as a focal point for discussions on changes to the business world.

2.1 Discussing a “new” economy leads to reifying distinctions in the “old economy”

In defining a new science of service systems, the meaning of service is problematic. In government statistics worldwide, categorizations of economic outputs have standardized on a three-way distinction: an agricultural sector, a manufacturing sector, and a service sector (Wölfli 2005). International studies on economic inputs have determined that Information and Communication Technology (ICT) capital has become sufficiently significant to be recognized alongside labour inputs and non-ICT capital (OECD 2000). Deeper examination of labour inputs makes a further distinction in talent recognized in creative-class occupations as something different from manual jobs in lower-paid service businesses (Florida 2002, 2004).

Presuming that students in graduate engineering and management programs will eventually become leaders in society, they should recognize that the drivers of value creation in the next 25 years will likely to change from those in the past 25 years. As they accumulate
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experience in business organizations – either in for-profit or not-for-profit designations – they will shape and be shaped by the work they do. Learning business history provides a viewpoint on how organizational practices have come to be. As their careers require these professionals to look forward, however, they should take advantage of opportunities to understand potential directions that their business may take as the economic and technological contexts change.

2.2 Systems science is a common ground for systems engineering and systems approaches to management

The motivation to view business through a lens of systems science is practical. The new science of service systems is driven by a “new” service economy in which definitions and theories are still evolving. This is a scientific revolution (Kuhn, 1967/1996). At this time, systemics, -- as “an open set of concepts, models and practical tools useful for a better understanding and eventual management of complex situations or entities of any type” (François 1997, p. 362) – enable a rich vocabulary and set of concepts for discussion.

Linkages of system science can inferred from the applications. In engineering, the body of knowledge is known as systems engineering shares concepts and definitions from systems science. In management, the body of knowledge is distinguished as a systems approach.

Definitions of systems engineering emphasize interdisciplinary / multidisciplinary features to varying degrees. The IEEE defines systems engineering as “an interdisciplinary collaborative approach to derive, evolve, and verify a life-cycle balanced system solution which satisfies customer expectations and meets public acceptability”. An alternative concise definition sees systems engineering as “a multidiscipline that addresses a system from a life-cycle, cybernetic and customer perspective” (Tien & Berg 2003, pp. 22-23). Although some would perceive engineering as based primarily in hard science, the systems engineering literature recognizes natural and human sciences:

[A] system [can be defined as] an assemblage of objects united by some form of regular interaction or interdependence ... A system can be natural (e.g., lake) or built (e.g., government), physical (e.g., space shuttle) or conceptual (e.g., plan), closed (e.g., chemicals in a stationary, closed bottle) or open (e.g., tree), static (e.g., bridge) or dynamic (e.g., human). In regard to its elements, a system can be detailed in terms of its components, composed of people, processes and products; its attributes, composed of the input, process and output characteristics of each component; and its relationships, composed of interactions between components and characteristics.

(Tien & Berg, 2003, pp. 23-24)

The lineage of engineering as an applied science serviced from theoretical knowledge is obvious.
Business Models and Evolving Economic Paradigms

Management – in itself, a multidiscipline – has hidden foundations from some leading thinkers who encourage a *systems approach*. While some see management as an art, others emphasize the science in management.

[Amongst] Management Scientists … the systems approach to problems is fundamental and … organizations, a special type of system, are the principal subject of study.

The systems approach to problems focuses on systems taken as a whole, not on their parts taken separately. Such an approach is concerned with total-system performance even when a change in only one or a few of its parts is contemplated because there are some properties of systems that can only be treated adequately from a holistic point of view. These properties derive from the relationship between parts of systems: how the parts interact and fit together. (Ackoff 1999/1974)

There is not a single systems approach in management. Generic methodologies have been constructed for a functionalist systems approach (with 7 categories of theories), an interpretative systems approach (with 7 categories of theories), an emancipatory systems approach (with 2 categories of work) and a postmodern systems approach, leading to development of a pluralist approach of critical systems thinking (Jackson 2000).

Since depth in at least one discipline seems to be a prerequisite for studying systems, a universal definition of systems science is an ongoing debate. However, systemicists would largely agree that systems science loses its value if it is seen as a discipline.

Systems science is a meta- or trans-discipline (or possibly better, a meta-methodology) for everybody, and should not be simply reduced to a discipline status, even when and where it must be taught [sic]. (François 1997, p. 362)

For the interests we have at hand – bridging the language and concepts of engineers and managers so that discussions of analysis and design can productivity proceed – systems concepts and languages can aid in clarity. The alternative is for the quality of discourse to fall to a common level of a Grade 6 education.

At some time in the future, it’s probable that the science of service systems will converge to become a normal science. Systems science will then recede into the background as a foundational body of knowledge, as it has with other engineering and management disciplines.

**2.3 Advances in technology changes the economics of a business by loosen constraints**

The reasonable of business directions is judged within paradigms. A paradigm is “a mode of viewing the world which underlies the theories and methodologies of science in a particular period of time” (New Shorter Oxford 1997). This definition recognizes that science has multiple branches. The new science of service systems is largely being
defined inductively from developments of society and business. In a practical evolutionary view, three stages have been proposed by “a nation’s economic evolution” – mechanical, electrical, and information (Tien & Berg 2003). This thinking can be extended to recognize advances in science with technology along a non-exhaustive list of disciplines, e.g.

- mechanical,
- biological,
- material/chemical,
- electrical, and
- information / communications.

Within each of these fields, paradigm shifts occur. In biology, the discovery of DNA led to the advent of molecular biology. In material science, nanotechnology is new. As much as shifts occur within these sciences, boundaries between disciplines are naturally redefined (e.g. biology and chemistry have led to biochemistry).

Business opportunities arise as paradigm shifts lead to technologies that change the possibility and feasibility of products and services.

The effect of technology is -- and always has been -- to loosen constraints. As a result of technological development, what was not possible becomes possible. Or what was not economically feasible becomes so. (Normann 2001, p. 27)

By the late 1990s, one significant paradigm shift for the sciences and the business world was in information, as digital content became networked, i.e. the Internet. These advances not only impacted computer science, but also other fields (e.g. bioinformatics in the life sciences). The conventional wisdom on a science of service systems will take some years to work through definitions and distinctions.

2.4 The value that a business creates is defined in its business model

Businesses – or more generally, purposive social systems – create value as organizations collectively, in ways that individuals alone cannot. As enterprises are viewed less as monolithic entities and more as network forms, the coproducers of business outcomes are being recognized as a value constellation (Ramirez & Wallin 2000). A customer or client may be served by a lead organization that coordinates with or subcontracts to alliance partners or other third parties. Fluidity of organizational boundaries invites reflection of the business model.

The business model defines the value-creation priorities of an actor in respect to the utilization of both internal and external resources. It defines how the actor relates with stakeholders, such as actual and potential customers, employees, unions, suppliers, competitors, and other internal groups. It takes account of situations where the actor's activities may
(a) affect the business environment and its own business in ways that create conflicting interests, or impose risks on the actor; or

(b) develop new, previously unpredicted ways of creating value.

The business model is in itself subject to continual review as a response to actual and possible changes in perceived business conditions. (Wallin 2006, p. 12)

In the above definition, an actor may be an individual or an institution such as a firm. A supplier can assemble an offering for a specific set of capabilities appropriate to the client – possibly appropriate only for that client – in a value constellation (Ramirez and Wallin 2000). Broadening interactions beyond quid pro quo monetary exchange to include the resources and ethos of social relations and institutions moves shifts the styles from microeconomics to economic sociology (Swedberg 2003).

With systems science, advances in technology and business models described above as a starting point, the context of evolving economic paradigms comes to centre stage. In the pursuit of rich conversations on value creation, we’ll now turn to a proposed set of system topics as platforms.

### 3. SELECTED TOPICS IN SYSTEMS SCIENCE PROVIDE LENSES FOR DISCUSSING CHANGES IN THE BUSINESS WORLD

For audiences of engineering and management students, education on systems science per se is not the primary goal here. Systems science is presented as a body of knowledge that can be applied. In this interest, ten topics are presented below to guide thinking and discussion about the business world. The number of topics is slightly arbitrary, but aligns with the practicality of teaching a seminar in a 10-week quarter or a 13-week semester. Systemicists are welcomed to develop their own lists suitable for their needs. The ten topics are:

- 1. Business models, value creation, and the “new economy”
- 2. Ignorance and knowledge
- 3. Boundary
- 4. Order, purpose, self-organization
- 5. Living, being, becoming
- 6. Energy and complexity
- 7. Form, networks and power laws
- 8. Information, communication and meaning
- 9. Coevolution, competition and variety
- 10. Aesthetics, ethics and morals

If these topics were to be pursued as a study of systems science per se, each topic could become a course by itself. As a way to better understanding business models, the content and references for each of these topics is described below.
3.1 Business models, value creation, and the “new economy”

The motivation and context for the seminar are outlined, following the content of this paper. It is important to distinguish between descriptions of business founded on rigorous definitions in systems science from those extending system metaphors.

3.2 Ignorance and knowledge

Despite the fact that we haven’t fully defined business based on a science of services system – and knowledge on manufacturing systems and agricultural systems continually evolves – we can and should move forward. From a systems perspective, what can we know and what should we know? Are there things about the business world that are unknowable?

The key reading draws on competence development and ignorance (Ing, Takala & Simmonds 2003). This reading includes embedded references to the College of Medical Ignorance (Witte, Kerwin & Witte 1998), the unbounded mind (Mitroff & Linstone 1993), the design of inquiring systems (Churchman 1971) and ecology of mind (Bateson 1972).

3.3 Boundary

Pure services businesses, manufacturing businesses and agricultural businesses don’t really exist. What are the boundaries of a business when viewed as a system? How do new informatic spaces (e.g. the Internet) impact social interaction in physical and social spaces? How does this relate to a business model? What are the considerations for inclusion or exclusion?

The key reading draws on viewing social interaction through mediating spaces (Ing & Simmonds 2002). This reading includes embedded references to business design (Ackoff, 1994) and pattern languages (Alexander, Ishikawa et al. 1977). Some definitional sources on open systems should be provided. Additional references include value constellations (Normann & Ramirez 1994) and critical systems theory (Jackson 2000).

3.4 Order, purpose and self-organization

Service businesses may or may not be different from manufacturing and agricultural businesses on unitary or plural directions and coordination. On which organizational dimensions should leaders set direction and/or bounds, and when should they let direction emerge? Which styles of coordination work in global businesses? What processes enable self-organization?

The key reading considers the balance between legal (rule-based) order and negotiated order in network form organizations (Parhankangas, Ing, et al. 2005). This reading includes embedded references to turbulent environments (Emery & Trist 1965) and
negotiated order (Strauss 1978). Additional references include goals, objectives and ideals (Ackoff 1981), context and coordination (Haeckel, 1999), the cathedral and the bazaar (Raymond, 2000), heterarchy (Hedlund 1986), and polycentric and geocentric organizations (Permutter & Heenan 1979).

3.5 Living, being, becoming

Can service businesses, manufacturing businesses and agricultural businesses be described as living in similar or different ways? Businesses are not static entities, but evolve and change. Still, they may have functions and structures similar to other types of systems. While many business people don’t think about the differences between system metaphors and systems models, they often lead to different conclusions.

The key reading draws distinctions between deterministic (mechanistic), animate (organismic), social and ecological models based on purposes in the parts and wholes (Ackoff & Gharajedaghi 1996). Three completely different approaches include living systems theory (Miller 1978), the viable system model (Beer 1972/1981, 1979) and anticipatory systems (Rosen 1985).

3.6 Energy and complexity

Natural science sees the world as matter, energy and information. If business assets are matter, can and should service businesses, manufacturing businesses and agricultural businesses expend energy into embodied forms? While Europeans and Asians caught on to the significance of petroleum and electrical costs in the 1970s, North Americans seem to have taken longer. Energy and complexity are related concepts, linked through hierarchy theory in ecosystem ecology. Businesses may gain a deeper understanding of capital as energy in a systems model.

The key reading makes an important distinction between complication and complexification (Allen, Tainter & Hoekstra 1999). This important distinction is more fully fleshed out in a later book (Allen, Tainter & Hoekstra 2003). The parallelism with energy is described in the mystery of capital (de Soto 2000). The centrality of energy is further defined in energy, power and society (Odum 2007). The entropy law is applied in innovations versus environmental protection presumptions (Hawk 1999), based on the entropy law and economic process (Georgescu-Roegen 1971). In regional development, it may be possible to design self-refueling systems as part of the nature of economies (Jacobs 2001)

3.7 Form, networks and power laws

The validity of the idea that form follows function can be challenged in information-intensive service businesses, and probably also contemporary manufacturing businesses and agricultural businesses. In systems theory, structure is an arrangement in space, and
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process is an arrangement in time. In rapidly changing business environments, growing without bulking up can be a challenge. Organizing a system as a set of loosely coupled parts results produces different properties in the whole.

One key reading associated with arrangement in space the cellular form organization appropriate for the knowledge age (Miles, Snow et al. 1997). A key reading associated with arrangement in time looks at how buildings learn (Brand 1994). A cautionary tale on tightly-coupled systems is presented as normal accidents (Perrow 1984). Network forms as common in social structures (Barabasi 2000), and now technologies are changing the structure of production to in favour of wealth of networks (Benkler 2006). Digitalization further separating information content from tangible content is shifting targeting from the mass market to the long tail (Anderson 2006).

3.8 Information, communication and meaning

Service businesses may or may not be different from manufacturing businesses and agricultural businesses in the ways that information is embodied in individuals and shared in communities of practice. In social interaction, information serves a variety of functions (e.g. directing, requesting) and can be interpreted with different meanings according to the context of the listener.

The key reading draws from computer science to view offerings as commitments, approaching service systems from a language action perspective (Ing 2008). This reading includes embedded references to appreciate doing and speaking in the office (Flores & Ludlow 1980) and understanding computers and cognition (Winograd & Flores 1986). Criticisms of overt control can be dissolved with Banathy-style conversations, with a homeopoeitic ethic for organizational change (Rowland 2004) and self-organization of public discourse (Walton 2004). The rise of information technologies leads to a deeper consideration of what computers still can’t do (Dreyfus 1992) and learning, meaning and identity in communities of practice (Wenger 1998).

3.9 Coevolution, competition and variety

A business can choose to cooperate, compete or not engage with others. The dimensions of coevolving relationships amongst and between service businesses, manufacturing businesses and agricultural businesses will vary, each with merits and demerits. Competition may or may not result in conflict. Cooperation can be different from coordination, if increased variety is desired. The rise of open source as sharing in communities contrasts to views of private source and ownership.

Definitions of types of interactions between species (e.g. parasitism, mutualism) are categorized in basic ecology (Odum 1983). The benefits of cooperation may show up with positive feedback as increasing returns (Arthur 1996). Within or outside the relationship, coordination may follow the law of requisite variety (Ashby 1956).
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Benefits may accrue from a design of diversity (Page 2007). If the relationship is not going well, partners may have to choose to express themselves through exit, voice and loyalty (Hirschman 1970). For large scale issues, however, there may be no exit, and action only as catastrophe looms large, as an upside of down (Homer-Dixon 2006). Reacting, rather than proactively or interactively dealing with these issues leads only to a post-normal science of precaution (Ravetz 2004).

3.10 Aesthetics, ethics and morals

Most of the business interest in systems science is oriented more towards economics and design. Working down from philosophy, however, there are some helpful systems approaches to the classical ideals of aesthetics, ethics and morals. In bridging across services businesses, manufacturing businesses and agricultural businesses, these systems concepts may be helpful.

Readings in this are should draw on the systems approach and its enemies (Churchman 1979), the four enemies being politics, morality, religion and aesthetics. Coming from a different perspective is the appreciative systems of Sir Geoffrey Vickers (Checkland, 2005). Both of these have influenced more recent work on systemic governance and creative problem solving through critical systemic praxis (McIntyre 2005). Contributing an understanding of commercial and more syndromes is systems of survival (Jacobs 1992)

3.11 From these topics, a system of concepts is coproduced inductively with each student

This seminar is designed not as a deductive manner where the textbook has been written. It has been designed as an inductive process, where a student with peers and a facilitator coproduce insight into business models. Each student will gain different insights, with a trajectory according to his or her personal interests. In this respect, the seminar follows a systemic philosophy where the structure of a system of system concepts will develop coherency within the mind of the student.

4. A DEMONSTRATION: BUSINESS MODELS APPROACHED FROM A SYSTEMS SCIENCE FOUNDATION

The seminar is more focused on process than an outputs, since each participant will take enrich his or her knowledge from his or own foundation of experience. For those individuals with an orientation more towards ends, this section demonstrates how systems concepts could produce a different view of the business world. This view is not intended to close off discussion, but to provoke conversations in yet another ways that the world could be seen.
The essential challenge, as a new science of service systems is being developed, is to rethink the distinctions of agricultural, manufacturing and service sectors, as well as the resources of land, labour and capital. As an example, three categories of resources are crossed with three categories of ethos to create a matrix of nine categories of business models.

4.1 The resources essential to the business define key functions

From a systems perspective, resources are inputs to business that largely define their contribution to society. Classical economics has recognized the inputs of land, labour and capital. Following the shifts in the economy, let’s consider three major types of resources:

- (1) renewable resources,
- (2) appropriable resources, and
- (3) cultural resources.

Renewable resources are replenished by nature. Human beings can offset the depletion of the resource through consumption by enabling replenishment or through conservation. Businesses based in renewable resources include farming and fishing. Major activities within such businesses include cultivation and harvesting.

Appropriate resources are generally non-renewable. They accumulate properties through manufacturing processes, where energy is expended to create forms recognized as man made materials and equipment. Businesses based in appropriable resources include extractive activities such as mining and petrochemical refining, and manufacturing activities such as building automobiles. Major activities within these businesses include acquisition and processing.

Cultural resources originate from human interaction. They are embodied in human beings and shared in practices of everyday life. Cultures include language, artistic expressions, rituals and behavioural norms. Cultural practices are reproduced with shared experiences and predispositions through family ties, social networks, history and institutions. In today’s world, human beings may adopt aspects of culture from regional domiciles, workplaces, generational cohorts and/or shared interests. Participating in these businesses includes affiliating with the culture (e.g. being accepted as legitimate by the community) and practicising the skills (e.g. being a player rather than an observer).

Describing a business by its essential resources is only a partial analysis. As a renewal resource, it’s different to grow vegetable on a farm from growing them in a hydroponic skyscraper. The mass production of automobiles is different from an antique restoration. Shooting a major motion picture is different from capturing home videos. This leads to another dimension: ethos.
4.2 The ethos of a business structures action in practices

An ethos is “the characteristic spirit of a culture, era, community, institution, etc., as manifested in its attitudes, aspirations, customs, etc.” (New Shorter Oxford, 1996). A business is social system, so there are varied and alternative structures of actions to produce similar types of outputs. From a systems perspective, ethos is part of the operation of the system. Let’s consider three types of ethos:

- (a) an organic ethos,
- (b) an industrial ethos, and
- (c) a service ethos.

Each feeling of each ethos comes through in engaging with an individual from that profession or community.

An organic ethos may be described as one that appreciates and nurtures the local bounty. An Amish farm may be the ultimate reflection of an organic ethos in agriculture.

What is underway on an Amish farm does not involve single purpose. The farms are not regarded as economic units, although the Amish make sound economic decisions. What we observe on the Amish farms is similar to what we observe on a natural ecosystem – homeostasis. Purpose and mechanism are transcended.

…. [The Amish] are interested in profit and high yield, but neither concern drives them as a single purpose. Had the Land Institute’s newly acquired 160 acres been an Amish farm, it would have been highly diversified … The living riparian community on each side of the two streams would have been a habitat for an abundance of wild species, including quail, pheasant and deer. It would have been a source of fuel, a boundary dividing the farm into smaller fields. It would host some predatory birds and insects. The smaller fields would have suited a horse- or mule-powered agriculture. The larger cottonwoods would have provided shade for grazing animals or for a resting team and driver. The fallen hackberry limb would have been converted into firewood. The straw that we plow under or burn would have would have become bedding for livestock and thus become a way of holding urine and manure, and all three would have returned to the fields from which they came. Some of the grain would be fed on the farm, some would be sold, depending on need.

Because the emphasis for the Amish is not exclusively on production, mass production of food on the farm is incompatible with their sense of how to live in the world. (Jackson 1987, pp. 128-129)

The description of an organic ethos in the context of business isn’t necessarily meant as an anti-technology bias; it’s meant as a way seems more natural to the community. Thus, photography on film holds an organic ethos for those from an age of chemistry in a way that digital photography does not.
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An industrial ethos is associated with efficient machinery, and describes much of the modern world. Machines extend the capabilities of human beings, replacing social functions with automated mechanisms -- either as improvements or degradations, depending on the point of view. Much of the business world implicitly takes the industrial ethos, from the days of Henry Ford’s Model T, to the current day.

Competitive advantage cannot be understood by looking at a firm as a while. It stems from the many discrete activities a firm performs in designing, producing, marketing, delivering, and supports its products. Each of these activities can contribute to a firm’s relative cost position and a basis for differentiation. A cost advantage, for example, may stem from such disparate sources as a low-cost physical distribution system, a highly efficient assembly process, or superior sales force utilization. Differentiation can stem from similarly diverse factors, including the procurement of high quality raw materials, a responsive order entry system or a superior product design (Porter 1985, p. 13)

The industrial ethos has a predisposition for finding more efficient ways of getting work done. It can be dispassionate about tradition, and thus surfaces advocates and resisters. The industrial ethos occurs not just in manufacturing businesses, but also in public enterprises. It is closely related to Weber’s idea of a machine bureaucracy, which served to eliminate nepotism in German civil service of the early 20th century.

A service ethos is associated with humility. Humility is the quality of having or showing a low estimate of one’s own importance. It is reflected in the person providing the service recognizing the wants and needs of the customer / client / citizen above his or her own position. A service ethos does not mean a lower societal rank, as can be demonstrated in the spirit of servant leadership.

The servant-leader is servant first…. It begins with the natural feeling that one wants to serve, to serve first. Then conscious choice brings one to aspire to lead. That person is sharply different from one who is leader first, perhaps because of the need to assuage an unusual power drive or to acquire material possessions…. The leader-first and the servant-first are two extreme types. Between them there are shadings and blends that are part of the infinite variety of human nature.

The difference manifests itself in the care taken by the servant-first to make sure that other people’s highest priority needs are being served. The best test, and difficult to administer, is: Do those served grow as persons? Do they, while being served, become healthier, wiser, freer, more autonomous, more likely themselves to become servants? And, what is the effect on the least privileged in society? Will they benefit or at least not be further deprived? (Greenleaf 1977, p.13)

The service ethos is commonly associated with service professions such as the clergy and nursing. This does not mean that for-profit businesses can not place value on serving customer and other constituents.
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Engineering and management professionals choose organizations with whom they associate, just as those organizations select the individuals. The ethos of an organization contributes to whether an individual does or doesn’t fit with its character.

4.3 Categories of business reference models aid reflection on distinctions

As a demonstration of an alternative view on business models, the three types of resources are crossed with three types of ethos to produce business model reference points. These are intended neither as practical nor complete, and seminar participants are encouraged to develop their own views.

Table 1. Business model reference points

<table>
<thead>
<tr>
<th>(1) Renewable resources: Cultivate and harvest</th>
<th>(a) Organic ethos: local bounty</th>
<th>(b) Industrial ethos: machine efficiency</th>
<th>(c) Service ethos: humility</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1a) Agroecological business model</td>
<td>(1b) Materials refining business model</td>
<td>(1c) Physical wellness business model</td>
<td></td>
</tr>
<tr>
<td>• (Amish) family farms</td>
<td>• Food processing</td>
<td>• Health care</td>
<td></td>
</tr>
<tr>
<td>• (Amish) family farms</td>
<td>• Pharmaceuticals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1b) Materials refining business model</td>
<td>(2b) Lean production business model</td>
<td>(2c) Security business model</td>
<td></td>
</tr>
<tr>
<td>• Food processing</td>
<td>• Petrochemicals</td>
<td>• Insurance</td>
<td></td>
</tr>
<tr>
<td>• Pharmaceuticals</td>
<td>• Automobile</td>
<td>• Banking</td>
<td></td>
</tr>
<tr>
<td>(2a) Handcrafting business model</td>
<td>(3b) Media publishing business model</td>
<td>(3c) Intellectual development business model</td>
<td></td>
</tr>
<tr>
<td>• Fashion apparel</td>
<td>• News</td>
<td>• Education</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Television and movies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(3) Cultural resources: Affiliate and practice

| (3a) Performative experience business model | (3b) Media publishing business model | (3c) Intellectual development business model |
| • Concerts                                  | • News                           | • Education                             |
| • Live theatre                             | • Television and movies          |                                        |

Each of the nine business model reference points described in Table 1 has unique features as systems.

The (1a) *agroecological* business model, as illustrated by family farms but exemplified by the Amish, are designed around renewal resources, operating with an organic ethos. Diversity of crops, livestock and byproducts enables near self-sufficiency, with local trade supplementing family efforts.

The (1b) *materials refining* business model begins with similar resources to the agroecological, but takes an industrial ethos with the use of machines. Examples include food processed are superhuman speeds, or pharmaceutical development of plant and animal extracts. Corporate agribusiness also follows this type of model.
The (1c) **physical wellness** business model takes natural living beings (i.e. human beings and animals), and applies a service ethos. Health care services in the spirit of nursing are of this type.

The (2a) **handcrafting** business model starts with appropriable resources but applies an organic ethos. Fashion apparel, where uniqueness and custom fit are important, places a high value on craftsmanship.

The (2b) **lean production** business model is based on appropriable resources, and the industrial ethos is a direct descendant of the mass production style of Henry Ford. Petrochemical and automobile production clear follows this type of business model.

The (2c) **security** business model takes appropriate resources – possibly slightly abstract, as in property rights – and applies a service ethos. Insurance means that if an insured item is lost, it can’t be lost again. Banking enables funds to be channeled from those who have plenty to those who have short-term obligations to meet.

The (3a) **performative experience** business model is founded on cultural resources (e.g. musical scores, actors) working in an organic ethos. Concerts and live theatres are valued for their immediacy, and the immersive experience has value to “being there”.

The (3b) **media publishing** business model takes the cultural resources (e.g. concert performances), and applies an industrial ethos. Live events (e.g. news as it happens) can be reproduced at lower fidelity and bandwidth for viewers with a lesser interest in the content.

The (3c) **intellectual development** business model starts with cultural resources (e.g. high school graduates) and applies a service ethos. Education is delivered through pedagogy.

The above nine business model references are provided as a foil against which the traditional three-sector categorization of agriculture, manufacturing and services is contrasted. Each of the references would be impacted to a varying degree by changes in a technology – that may or more not be relevant to the core resources or ethos. The goal for the seminar is not to validate this business model reference, but for each participant to develop a perspective helpful and valuable for his or her own domain of focus.

5. EDUCATION IN ENGINEERING AND MANAGEMENT AS A SINGERIAN INQUIRING SYSTEM IS APPROPRIATE FOR AN EMERGING SCIENCE

The fifth way of knowing (Mitroff & Linstone 1993, Churchman 1971) is a Singerian inquiring system. It is an open system where features of inductive-consensual, analytic-deductive, multiple-reality and dialectical thinking are all included, and new ideas are continually swept in. In contrast to viewing disciplines having closed and fixed boundaries (e.g. this idea belongs to economics, that idea belongs to sociology, and the
other idea belongs to political science), a systems approach to engineering and management is appropriate for future-facing perspective.

In time, a science of service systems will mature, and manufacturing and agricultural businesses will continue to evolve. This seminar is designed to welcome and embrace the ambiguity of an emerging science.

REFERENCES


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A SYSTEMS APPROACH TO STREAMLINING THE CREATION OF WEB-BASED CONTENT

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ABSTRACT
In a wired world, the information one already knows is becoming less important than how adept one is at conducting effective searches for the information one desires. In the case of publicly-available, indexed information resources such as those made possible by the World Wide Web, content that cannot be found may as well not even exist in terms of its usefulness for human consumption.

The need for content to be findable on the Internet presents an important challenge for creators of content intended for consumption on the Web. Specifically, the content one creates must not only be valuable (i.e., useful and relevant within the context of a particular need) to human consumers, but it also must be properly indexed by search engine agents so that it can be made accessible to those consumers in the first place. Given the complexity of this dual requirement, content developers today lack a framework for guiding them in creating content that consistently satisfies both of these requirements.

In order to assist the creators of online content to do so in a way that is both findable and valuable to human consumers, the current paper proposes a systems approach to modelling the complex relationship between Web-based content, the immediate content needs of its intended human consumers, and the technology agents that index that content for human consumption. The intended outcome will be a Content Consumer Profile which future content creators can leverage to help them create content effectively and efficiently.

Keywords: information search, Web-based content, systems approaches, content consumption, search engines

A SYSTEMS APPROACH TO STREAMLINING THE CREATION OF WEB-BASED CONTENT

Information Search in a Wired World

The Increasing Ubiquity of Information
As the people and organizations of the world become increasingly interconnected via the Internet, information of almost all sorts is ever-more readily accessible to the average citizen of many countries around the world. As information technologies such as processors and storage devices continue to become more affordable from year to year, this trend should continue.

For the first time in history, almost any type of information can be accessed for free by anyone who is adept at searching for it. While much of the information available on the World Wide Web remains part of the invisible Web (Schlein, 2006) - content that stipulates fee-based access or that
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is not indexed by search engines at all - there is an unprecedented amount of information available to us that was unimaginable even 50 years ago.

The New Game: Being able to Find the Right Information Quickly
While having knowledge and information “in one’s head” are still very important for many business, academic, governmental and personal contexts, the sheer amount of information in the world today is changing the rules of the information game. And, as the world speeds up, some of the most important information itself is changing more quickly than ever, making it even more important for people to constantly gain access to new information as it becomes available. Nowadays, for many people it is as or more important to be able to effectively access the information one needs than it is to be able to memorize large amounts of data. Search, rather than memorization, is the new name of the game in most areas of information-intensive human endeavour.

Advances in Search Technologies
Commensurate with this marked increase in the ubiquity of readily-available information has been rapid advances in search technologies. Since the introduction of the first search engine, Archie, by a McGill University student in 1990 (Battelle, 2005), search technologies have come a very long way in terms of their ability to connect relevant content to would-be consumers of that content. And the infrastructure that enables search has been bolstered significantly as well: it is estimated that most popular search engine, Google, employs upwards of 200,000 servers in indexing and delivering content to hungry Internet searchers.

Increased Pressure to Provide Relevant Content
The playing field for search companies has also significantly narrowed over the past decade, with the top three search engines (Google, Yahoo! and MSN) comprising about 88% of all daily searches on the Internet. Since there are significant revenue opportunities in the area of search for these companies, this narrowing of the field means that the top search firms are under continual pressure to provide increasingly relevant, valuable content to consumers. Only high levels of relevance for search results can guarantee that the top search engines will retain their positions - and their revenue streams derived from their search-related ventures.

Content: The Primal “Stuff” of the Internet
The World Wide Web and the industry of Internet search would not be possible without the existence of content. Content refers to any type of text or media-based item that people want to consume (viz., read, watch, play with, manipulate or listen to).

The amount of content on the Internet is unimaginably huge and growing constantly. This means that it is impossible for any individual or organization to meaningfully consume more than a tiny fraction of the content that exists on the Internet. At the same time, the large amount of content available provides an enormous array of opportunities for individuals to find content that suits their particular needs. Searchers for content are only limited by their imaginations and their competence in executing proper searches for the type of content they desire.

Content Creation and Delivery Landscape
The primary stakeholders involved in the creation, storage, and delivery of content on the Internet can be broken into three primary categories: creators, indexers and consumers. Each of these has their own unique goals, motivations and challenges.

Content creators have the goal of creating content that some target group will be able to find, consume and find valuable. Most creators of content have the key motivation of doing so to meet certain personal or organizational goals such as earning revenues, raising awareness about a certain
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topic, or eliciting inbound contacts. Content creators face the challenge of competing with thousands or millions of others who are creating content that either actively targets the same audiences, shows up among the same search results as their own content, or both.

Content indexers are defined here as any company, individual or its electronic agents that scans (or crawls) as many Web sites on the Internet as possible, indexes the content that is found there, and then provides that content among search results for potential access by content consumers. The goal of content indexers is to provide content that best matches the inferred intentions of the keyword-based searches conducted by content consumers. The key motivation of indexers is usually to generate revenues through the selling of advertising or related, Web-based services such as Web hosting. The challenge for content indexers is the perennial difficulty in accurately inferring the intentions of searcher (i.e., consumers) based upon the keywords the searchers use when conducting searches. Another challenge is the indexers’ ability to appropriately rank some content over other content in the search results list based upon perceived relevance.

Meanwhile, content consumers have the goal of accessing and consuming the highest-value content they can find. In this case, “value” is a function of the relevance of the content to the user’s search keywords and the usefulness of the content in terms of its intended area of application or means of consumption. The key motivation of content consumers involves fulfilling a need or desire (e.g., answers a question, provides a sense of community, offers entertainment, provides revenue opportunities, etc.). The challenge that content consumers face is that of sifting through the preponderance of content available on the Internet to find the content one wants (or believes one wants).
Figure 1. Structural Model of the Internet Content Delivery Landscape: Creators, Indexers, and Consumers
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CATWOE Analysis of Internet Content Creation and Consumption

The Internet landscape can be viewed as a system of content creation and consumption. The CATWOE approach of Checkland and Scholes (1990) offers a useful means for gaining insight into the key elements – or root definition - of any system. CATWOE stands for Customers, Actors, Transformative Process, Worldview, Owners, and Environmental Constraints. It is applied here in order to provide a root definition for Internet-as-system.

Customers

The customers of a given system are those who directly benefit from the transformative process (see below). In the case of the Internet landscape, the primary beneficiaries of the creation of content are the content consumers. In sense, the indexers and the content creators are also potential beneficiaries of the Internet-as-system. However, in the context of this paper, we will view the content consumers as the primary customers of the Internet-as-system.

Actors

The actors of a given system are those who perform the transformative process for the benefit of the customers. For our model, the actors are both the content creators and the content indexers.

Transformative Process

The transformative process for a given system is that which transforms inputs to outputs. In the case of our model of Internet-as-system, the transformative process entails the creation, discovery, indexing and delivery of content to consumers.

Worldview

The worldview for a given system is those set of beliefs, assumptions and values that underpin the existence of the said system in the mind’s of the majority of its stakeholders. The worldview that supports the Internet as an idea is that the Internet is a universally-accessible medium for the dissemination of user-relevant content to anyone, anywhere and in an unbiased manner.

Owners

The owners of a given system are those people or entities who could put an end to the existence of the system. In the case of the Internet, many would argue that there are no true owners since it is by definition a decentralized collection of multiple independent networks. If pressed, we can assert that the owners of the Internet are the Internet Service Providers (ISPs) who provide individuals and organizations with access to the Internet, as well as the large multinationals like AT&T and WorldCom who own the large Internet backbones over which the majority of Internet traffic travels.

Environmental Constraints

The environmental constraints of a system relate to those items that place limitations on its operation or use. The environmental constraints of the Internet include: 1. limitations to the indexers’ ability to infer consumer intentions from their search keywords, and 2. lack of a universal standard for content quality and relevance.
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Figure 2. CATWOE Analysis of Internet Content Creation and Consumption

A Two-Fold Challenge for Content Creators

A number of how-to guides have been written for content consumers concerning ways to improve the efficiency and effectiveness of conducting Internet searches. In a similar vein, search engine firms continually conduct extensive research into finding ways to improve their effectiveness in delivering the most relevant content to users in the timeliest fashion. However, there seems to be missing in the literature sufficient guidelines for content creators in a way that helps them to
maximize their goals of creating content that consumers will be able to find and that they will value when they consume it. This paper makes an attempt to address that gap in the literature.

Findable Content

Content first and foremost must be able to be found by the target content consumer group for which it was intended. The ability for content to offer value to people is null if the said content cannot be found in the first place by those who might benefit from it.

*Findable content* is content that can be found through the reasonable efforts of people who are either actively searching for the type of information the content offers or by those who might stand to benefit from the content by merely “surfing” or browsing the Internet with only a vague sense of the purpose of their search. The key elements of findable content the following:

- Keyword-optimized
- Streamlined technical elements
- Hosted on a search engine-trusted site
- Host site has multiple backlinks
- Host site is listed in Internet directories
- Content creator has a budget for paid listings

Many creators of content fail to take the appropriate steps toward ensuring that the content they create will be found by the target consumer group.

Valuable Content

Of course, even if content one creates can be found effectively, it must also be perceived as valuable by its target consumer group if it is to be leveraged effectively.

*Valuable content* is content is both perceived as useful by a particular content consumer group and is at the same time relevant for use in a given context. The key elements of valuable content are as follows:

- Fulfils consumer needs/desires
- Packaged in an Internet-friendly format
- Keyword-optimized
- Appropriately-targeted
- Implies a credible and trustworthy source
Figure 3. Criteria for Valuable and Findable Content

<table>
<thead>
<tr>
<th>Valuable</th>
<th>Findable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fulfills Consumer Needs/Desires</strong></td>
<td><strong>Keyword-Optimized Content</strong></td>
</tr>
<tr>
<td>Gets them closer to what they need or want</td>
<td>Key elements (e.g., title, anchor text) are</td>
</tr>
<tr>
<td>Answers a question</td>
<td>topic-specific</td>
</tr>
<tr>
<td>Provides actionable information</td>
<td>Content contains 3-5% of target keyword(s)</td>
</tr>
<tr>
<td>Yields a competitive advantage</td>
<td>Optimized for keywords that are often-</td>
</tr>
<tr>
<td>Increases pleasure</td>
<td>searched</td>
</tr>
<tr>
<td>Decreases pain</td>
<td>Optimized for keywords that are under-</td>
</tr>
<tr>
<td>Offers a sense of community</td>
<td>represented on other sites</td>
</tr>
<tr>
<td>Presents revenue-generation opportunity</td>
<td><strong>Streamlined Technical Elements</strong></td>
</tr>
<tr>
<td>Saves money</td>
<td>Code that underlies online content vehicle</td>
</tr>
<tr>
<td>Generates professional or personal contacts</td>
<td>(e.g., Web site, blog) needs to be</td>
</tr>
<tr>
<td>Alleviates a worry or concern</td>
<td>streamlined so that search engine crawlers</td>
</tr>
<tr>
<td>Provides hope or inspiration</td>
<td>can find and index the content</td>
</tr>
<tr>
<td><strong>Internet-Friendly Format</strong></td>
<td><strong>Hosted on Search Engine- Trusted Site</strong></td>
</tr>
<tr>
<td>Easily-digestible format</td>
<td>Content like articles and blogs that is hosted</td>
</tr>
<tr>
<td>Presented in a way that is easy to store</td>
<td>on a site trusted by search engines ranks</td>
</tr>
<tr>
<td>for later consumption</td>
<td>better in natural search results</td>
</tr>
<tr>
<td>Accompanied by audiovisual aids</td>
<td>Content hosted on sites with high Google</td>
</tr>
<tr>
<td></td>
<td>PageRank™ ranks better on Google</td>
</tr>
<tr>
<td><strong>Keyword-Optimized Content</strong></td>
<td><strong>Host Site has Multiple Backlinks</strong></td>
</tr>
<tr>
<td>Contains instances of search keyword</td>
<td>Having multiple other contextually-relevant</td>
</tr>
<tr>
<td>Key elements (e.g., title, anchor text) are</td>
<td>sites “point” links to host site contributes</td>
</tr>
<tr>
<td>topic-specific</td>
<td>better rankings</td>
</tr>
<tr>
<td>** Appropriately-Targeted Content**</td>
<td><strong>Host Site Listed on Internet Directories</strong></td>
</tr>
<tr>
<td>Tailored to psychographic profile of target</td>
<td>Listed on top 2-3 directories</td>
</tr>
<tr>
<td>consumers</td>
<td>Listed on multiple second-tier directories</td>
</tr>
<tr>
<td>Catchy and relevant title</td>
<td></td>
</tr>
<tr>
<td>Appears made for people “just like them”</td>
<td></td>
</tr>
<tr>
<td><strong>Credible &amp; Trustworthy Source</strong></td>
<td><strong>Budget for Paid Listings</strong></td>
</tr>
<tr>
<td>Few grammatical errors</td>
<td>Content creator pays for favorable search</td>
</tr>
<tr>
<td>Few syntactical errors</td>
<td>engine placement</td>
</tr>
<tr>
<td>Few typographical errors</td>
<td>Content creator pays for ads on cost-per-</td>
</tr>
<tr>
<td>Well-written copy</td>
<td>click or cost-per-impression basis</td>
</tr>
<tr>
<td>Well-structured flow</td>
<td></td>
</tr>
<tr>
<td>Trusted or trustworthy-seeming source</td>
<td></td>
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</tbody>
</table>

Content Consumer Profile

Creating content that is both findable and valuable is something that most content creators take for granted, resulting in the content they create not being found by the intended consumer group and/or not being valued. The result is that the goals of these content creators are not being met sufficiently, with potential adverse impacts for indexers and consumers, as well.
A Systems Approach to Streamlining the Creation of Web-Based Content

The majority of the factors in creating findable and valuable content are rooted in an understanding of the “who, what, when, why and how” of the target consumer group will be using the content. This paper proposes the creation and use by content creators of a Content Consumer Profile (CCP). The CCP would be created and filled out by the content creator before the content for a particular Web site, blog, online article, news item or other item is created. The purposes of the CCP are:

- To orient the content creator to the nature of the consumer or consumers of the content
- To serve as a guideline to which the content creator can refer repeatedly during the creation of the content such that the content created is both valuable and findable by the target consumer group

The exact format and contents of the CCP employed by a given content creator would vary. However, the CCP should consist of at least the following components: demographic profile, psychographic profile, technology profile, motivations for search campaign, details of search campaign, and content search history. (Note: search campaign is defined here as a series of one or more searches by a single content consumer that are tied together by a certain intention or set of intentions vis-à-vis the outcome of the search).

Demographic Profile

The demographic profile for a given group may include details such as location, age range, gender, occupation, income, average education level, nationality, marital status, children/dependents, and other relevant demographics.

Psychographic Profile

The psychographic profile can include items like personality characteristics, likes, dislikes, hobbies, overarching opinions or attitudes, values, concerns, life goals, decision-making style, who or what influences their opinions, what impresses them, how conservative are they in terms of being open to new ideas, and what it takes to earn their trust.

Technology Profile

The technology profiles includes items such as how tech-savvy they are, frequency and duration of Web use, locations from which they access the Internet (e.g., work, home, etc.), most often-visited sites, general attitudes toward technology, fears about technology, propensity to belong to online groups or communities, and the degree to which they express emotions online.

Motivations for a Given Search Campaign

The profile on motivations for a given search campaign include their reasons for searching for the target content, the pain they are trying to overcome, and their expectations for the interaction.

Details of a Given Search Campaign

Details of a given search campaign include whether they were deliberately or only passively searching for this content, what problems they encountered, and what are their search or content-related annoyances and pet peeves.
A Systems Approach to Streamlining the Creation of Web-Based Content

Content Search History

Finally, the content search history profile includes items such as whether they have searched for this type of content in the past, the types of sites (e.g., corporate sites, blogs, forums, etc.) they normally use to search for the content, and the types of sites they avoid or find least useful.

Methodology for Filling out the CCP

One or more CCPs will be created for each subject area with which the content creator is involved. At the outset of a given project, it may not be clear exactly how many CCPs will be required for a given content area; this will become clearer as the initial CCP is created. Creating the CCP is thus an iterative process, requiring that the content creator go back and forth between information that he or she finds about the content consumers and the evolving CCP itself. During this process, it may become apparent that more than one CCP is needed in order to represent two or more distinct content consumer groups, each with different reasons or motives for potentially consuming the content that will be created.

In gathering data for the CCP, the content creator may choose to visit multiple online resources such as forums, discussion groups, blogs, and group pages. Content that describes people’s thoughts and experiences in the first-person can yield very important insights into that particular consumer group. At the same time, objective, second-person or third-person accounts or studies about the group may also yield very valuable information that can be used to complete the CCP.

The content creator filling out the CCP may also choose to glean relevant information from resources such as interviews, surveys, focus groups, periodicals, books, and direct observation - or even from one’s own knowledge and experience.

It is important to note that not every section of the CCP need be filled out. This will likely be true for sections whereby the item is either not relevant for gaining insights into this particular content consumer group or whereby the information is not readily available via the information resources at the disposal of the content creator.

A continual challenge will be how to know when a particular CCP is complete and accurate. For example, it will be difficult to know whether the information one has gathered about a particular content consumer group is merely anecdotal or whether it actually represents tangible evidence about the nature of the consumer group in question. However, it is expected that experienced researchers will come to know when a particular profile is complete as they reach a point of information saturation. This point has likely been reached if the content creator notices an increased incidence of repeat or “known” information about a given group after extensive searching has been completed, while at the same time there is very little new information being revealed about the target group.

Conclusion

The increased availability of information that the Internet and its supporting technologies afford people today have shifted the importance from the ability to memorize information to the ability to access relevant information, or content. The primary stakeholder groups in the creation and consumption of content on are content creators, indexers, and consumers. Each of these stakeholder groups has a unique set of goals, motivations, and challenges pertaining to their role in the creation, discovery, indexing, and delivery of content to content consumers on the Internet. The Internet content and creation landscape can be seen as a system, with well-defined customers, actors, transformative processes, a supporting worldview, owners and environmental constraints that constitute the root definition of the Internet-as-system.
A Systems Approach to Streamlining the Creation of Web-Based Content

There is ample literature on how content consumers can conduct more effective searches, and content indexers (i.e., search engine firms) are under continual pressure to make search more efficient and effective such that the right content is delivered to the right consumers. However, there is a gap in the literature that informs content creators on how to create content that is both findable and valuable to a particular content consumer group.

The present paper proposes that content creators would be able to create content that is more findable and valuable if they are guided and informed by a clear understanding of the target content consumer group for which the content is ultimately being created. To that end, the paper proposes that content creators create and fill out a Content Consumer Profile (CCP) that details the primary characteristics and search-related motivations of a given group vis-à-vis the content in question. This will allow them to create much more findable, valuable content the further the goals of all key stakeholders in the Internet-as-system.

REFERENCES

ARE ORGANISATIONAL SIZE AND EFFICIENCY ENGAGED?

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ABSTRACT

Firm size is relevant in discussions on competition policy, integration, market structure and size. And undeveloped countries differ from developed countries in being relatively more dependent on technology imports and foreign competition, hence results from large countries may not hold.

In the other hand, small firms, say the others, advantages are more related to entrepreneurial dynamism, internal flexibility, responsiveness to changing circumstances and specialized expertise, which contribute to higher innovation efficiency in skill-intensive sectors enjoying rapid technological development. And Audretsch (1995, p.178) saw small enterprises be the engine of innovative activity in certain industries, despite an obvious lack of formal R&D activities.

Geoffrey West (2007) showed evidence from the US, those small firms to be less likely to patent than large firms. In contrast, in related areas, such as biotechnology, pharmaceuticals, etc., so called serial innovators, with an accumulated portfolio of technologically important and scientifically linked patents, were more likely to be small than large firms (CHI Research, 2003).

Organization and efficiency, together, remind us, frequently, a factory surrounded by a high brick wall and manned by a force of people working in eight hours shifts. And, of course, in this wisdom we are afraid that in an effort to increase the efficiency, the freedom of working out the innovation in its own way, and at its own convenience will be curtailed.

Red tape is not confined exclusively to the business of the government, but may be found entangling the work and impeding progress in any large organization. It is safe to say that the greatest difficulties which the average innovator has to overcome are not involved in his task itself, but are those thrown in his way by man-made organizations. Usually these obstacles are constructed in the name of efficiency and by those who are employed to assist, not to obstruct.

The danger in any organization of innovation & change lies in the tendency to submerge the individuality of the worker. In such organization it is not dealing with machines, or with pieces workers. In innovation & change the unit of the organization is a developed human mind. The product which this organization turns out is the result of the thought of the workers, and just so far as the organization inhibits or distracts these minds from their true course is inefficient. On the other hand, the organization promotes efficiency so far as it tends to permit and to stimulate originality and
Are Organisational Size and Efficiency Engaged?

freedom of thought in any worker, and at the same time to coordinate and concentrate the activities of the several workers on the problem on hand.

Many processes which work well in small scale develop defects when tried on a large scale, and vice versa. Many methods of real value have never gotten beyond his scale, because there was no one with sufficient interest, or technical knowledge to adapt the process to the new scale. Thus there is a great economic loss which can be overcome by proper organization.

We believe there is not sufficient support to the thesis about the advantage of larger than small firms. And we remembered the words of Illya Prigogine (1997): “The little groups can give changes to society as a hole. Minorities had show remarkable power in the past. Thinking the change only succeed by majorities is wrong. It's wrong to think that conscious is determined by economic and social structures, and they are here now and ever. What will be tomorrow could be totally different from today”.

Keywords: size – efficiency – innovation - small firms - large firms.

INTRODUCTION

Firm size is relevant in discussions on competition policy, integration, market structure and size. And undeveloped countries differ from developed countries in being relatively more dependent on technology imports and foreign competition, hence results from large countries may not hold.

Schumpeter hypothesis assumes larger firms to enjoy better access to knowledge-producing inputs and be more able to be innovative and improve their productivity. Evidence in favour of this hypothesis have been found by many researchers (see Berghäll, 2006, for the authors), rather the opposite also be found for others (e. g. Baldwin, 1995; Roca Sagalés and Sala Lorda, 2005; Johnson, 2006).

Pagano and Schivardi (2003) found a positive relationship between firm size and growth and explained it with R&D intensity, suggesting that larger size fosters productivity growth because it allows firms to take advantage of all the increasing returns associated with R&D, and that the causality runs from firm size to growth. And argue the full exploitation of innovation benefits from the presence of large firms, though small firms play an important role by experimenting and introduce new products. Large firms are more crucial in the development phase; by accelerate the diffusion and commercialization of new ideas and maximizing their impact on productivity.

Also, the mentioned researches on firm size suggested a more permanent combination with different roles assigned, with small firms being central to
Are Organisational Size and Efficiency Engaged?

innovation and technological diffusion, while large firms reap scale economies and high returns on R&D.

In the other hand, small firms, say the others, advantages are more related to entrepreneurial dynamism, internal flexibility, responsiveness to changing circumstances and specialized expertise\(^2\), which contribute to higher innovation efficiency in skill-intensive sectors enjoying rapid technological development. And Audretsch (1995, p.178) saw small enterprises be the engine of innovative activity in certain industries, despite an obvious lack of formal R&D activities.

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The work of West, Brown and Enquist, in biological issues, wrestled with the idea that the scaling laws may be related to the structure and hydrodynamics of the networks that supply nutrients to the cells in an animal's body. After a year of intense activity, the trio discovered that scaling results from the fractal-like structure of the network. They came up with three fiendishly simple universal postulates, grounded in the principle of natural selection, from which the scaling laws can be deduced mathematically. The first of these was that the network fills the whole of an organism's body. The second was that the diameter of the smallest branches in the network does not vary from one species to another since cell size is about the same in all species. And the third was that fluid flows throughout the network with minimum energy loss (Cartlidge, 2001).

Then West and al translate their law to cities or companies, believes size matters. West writes: “Although we can’t yet predict how specific cities or companies will evolve, we’ve found general mathematical relationships between population size, innovation, and wealth creation that may have important implications for growth strategy in organizations. ... Social organizations, like biological organisms, consume energy and resources, depend on networks for the flow of information and materials, and produce artifacts and waste. So it would not be surprising if they obeyed scaling laws governing their growth and evolution. Such laws would suggest that New York, Santa Fe, New Delhi, and ancient Rome are scaled versions of one another in fundamental ways—as, potentially, are Microsoft, Caterpillar, Tesco, and Pan Am. To discover these scaling laws, Luís Bettencourt at Los Alamos National Laboratory, José Lobo at Arizona State University, Dirk Helbing at TU Dresden, and I gathered data across many urban systems in different countries and at different times, addressing a wide range of characteristics including energy consumption, economic activity, demographics, infrastructure, intellectual innovation, employment of ‘supercreative’ people, and patterns of human behavior such as crime rates and rates of disease spread. ... To our surprise, a new scaling phenomenon appeared when we examined quantities that are essentially social in nature and have no simple analogue in biology—those associated with innovation and wealth creation. ... A doubling of population is accompanied by more than a doubling of creative and economic output. We call this phenomenon ‘superlinear’ scaling: by almost any measure, the larger a city’s population, the greater the innovation and wealth creation per person. ... The social and structural similarities between cities and firms suggest that our conclusions extend to companies and industries. If so, the existence of superlinear
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scaling that links size and creative output has two important consequences: First, it challenges the conventional wisdom that smaller innovation functions are more inventive, and perhaps explains why few organizations have ever matched the creativity of a giant like Bell Labs in its heyday. Second, it shows that because organizations and industries must apparently innovate at a continually accelerating rate to avoid stagnation, economizing by reflexively cutting R&D budgets and creative staffs may be a dangerous strategy over the long term.” (HBR, 2007).

Many other researchers conclude the opposite. There is only one answer? We think not. Our first argue is about the translation from biology to social systems. As Capra (2007) say: “...a social system is not the same as an individual organism. So it is a living system, but it's not an organism. (...) Biological networks operate in the realm of matter; social networks operate in the realm of meaning. Both produce material structure and social networks also produce the nonmaterial characteristics of culture-values, rules of behaviour, shared knowledge, etc.”

And there are other important differences. Capra continues to write: “Biological networks produce and sustain a material boundary, which imposes constraints on the chemistry that takes place inside it. Social networks produce and sustain a nonmaterial, cultural boundary, which imposes constraints on the behaviour of its members”.

INNOVATION AND EFFICIENCY IN ORGANIZATION

Productivity growth, innovation and technological change are very important to maintaining competitiveness in a global economy. In developed countries, large amounts are invested in R&D, supported by publicly financed share (Berghäll, 2006). The effectiveness of technological policy varies greatly from countries and firms. As Berghäll say, SMEs are most eligible for public R&D support, with the assumption they are more likely to suffer from financial constraints, while support granted to large firms generally attracts a great deal of criticism. Support granted to large firms can also be perceived to interfere with the creative destruction process.

Efficiency is a word associated with a systematized effort to increase the output of machines and manual labor. From this it has come to associate efficiency with stopwatch studies, close supervision, time cards, and detailed reports. And sometimes the word organization is associated with supervision, administrative duties, with everything that is the antithesis of the freedom of thought and action assumed to be essential to real innovation.

Organization and efficiency, together, remind us, frequently, a factory surrounded by a high brick wall and manned by a force of people working in eight
hours shifts. And, of course, in this wisdom we are afraid that in an effort to increase
the efficiency, the freedom of working out the innovation in its own way, and at its
own convenience will be curtailed.

Red tape is not confined exclusively to the business of the government, but may
be found entangling the work and impeding progress in any large organization. It is
safe to say that the greatest difficulties which the average innovator has to overcome
are not involved in his task itself, but are those thrown in his way by man-made
organizations. Usually these obstacles are constructed in the name of efficiency and
by those who are employed to assist, not to obstruct.

Many of the complications of organization have resulted from the application of
the fallacy that efficiency and economy can be promoted by the consolidation of small
units into larger ones. As the organization grows the worker becomes further removed
from the source of authority, the paths through which the business of the organization
must pass become devious and full of obstacles, and the hands of the worker become
tied by regulations and precedents. The economy of consolidation is also more
frequently apparent than real. For example, if the function of a unit is merely to
distribute something at the least possible expense, no doubt this end could be best
accomplished in a centralized unit, but it is better to appear extravagant by spending
money for branch units than to have a some force work for weeks or months on a
problem because, through difficulty in getting that thing, they are ignorant of the fact
that the problem have been solved.

One of the windmills against which the organizers most frequently tilt is the
duplication of work. It is easy to see that in certain types of work duplication does
become a great evil, but; for example, in research work it is not duplication but the
lack of duplication that is to be avoided. Few investigations lead to wholly correct
conclusions and new results become established as facts only when they are
confirmed by several workers.

The money with which the worker’s salary is paid, and his equipment
purchased, may have been provided for the solution of a problem, and it does not
seem unreasonable to expect him to stick to this last. The particular method by which
he attempts to solve the problem is another question. Some men are successful only
because, throughout their career, a skilful pilot has held them to the course.

The efficiency of existing organizations is to be increased by coordination and
consolidation. One problem of organization is continually with the worker whether he
welcomes it or not. No factory is so small to avoid it. When a man becomes an
assistant he faces an organization problem and his is, perhaps, the more difficult one
because he lacks the authority to put his ideas into effect.

In building up an organization there are certain obvious ends to be gained and
certain obvious evils to be avoided. It perfects the organization to obtain efficiency. It
have a program of work planned, a particular end to attain, and the money available
should be so expended that it carries it the greatest possible distance on the road to that
end. Of even great importance is the necessity of expending the energy and ability of
the workers so that they will yield the greatest returns.

The danger in any organization of innovation & change lies in the tendency to
submerge the individuality of the worker. In such organization it is not dealing with
machines, or with pieces workers. In innovation & change the unit of the organization
is a developed human mind. The product which this organization turns out is the result
Are Organisational Size and Efficiency Engaged?

of the thought of the workers, and just so far as the organization inhibits or distracts these minds from their true course is inefficient. On the other hand, the organization promotes efficiency so far as it tends to permit and to stimulate originality and freedom of thought in any worker, and at the same time to coordinate and concentrate the activities of the several workers on the problem on hand.

In considering means of attaining this end it must keep in mind the distinction between the methods of the factory efficiency and those which must prevail in innovation & change. In the factory the road to efficiency leads through system, routine, supervision, coordination of men and machine, office records and elimination of unnecessary motions. In the innovation & change case, efficiency is obtained by reduced supervision to the lowest point compatible with the ability of the worker; by removing him from the distractions of routine work; by surrounding him with an atmosphere conducive; by providing him with the special tools necessary to obtain the ends, and by promoting a spirit of collaboration which unite the individual men into a compact body working together.

However, in building that organization on the individual worker it must keep in mind that there are diverse kinds and condition of men. Innovators and entrepreneurs may be divided into two classes, the leaders and the followers. Permit us to put an example of the history of Argentina in nineteenth century: Fontana and his explorers who blazed the way through the mountains and the pathless forest into the Andes valleys made a great Patagonia possible, but without the settlers who followed in their footsteps and turned the wilderness into productive farms and cities their effort would have been valueless and forgotten.

The leaders and entrepreneurs are the exceptional men, with imagination, who have the faculty of grasping the significance of something that to the ordinary worker seem trivial or incomprehensible, and who, by a series of brilliant planned steps, push the future. For a man of this type, the organization must afford with latitude in the selection of matters and in the method to try them. On the other hand, there are many men who, if left to the dictates of their own imagination, flit from one unfinished project to another and accomplish little beyond their own entertainment, while they may, under the right leadership, become good workers. For these men a more rigid system is necessary. For the great majority of innovators & entrepreneurs, perseverance and logical thinking all that is necessary is the essential equipment and an opportunity to develop their ideas.

In developing an organization consideration must also be given to the type of work to be done, although the underlying principles apply to all cases. A big difference is in the primary object to be gained. The organization and methods of work will necessarily be along different lines. And it is very easy to make diagrams on paper showing how, in a logical way, this should be done, but diagrams, no matter how well be done, cannot really represent human beings. Whatever type of organization is chosen, the executive functions will be center about the administrative head of the firm. The head of an innovative organization, or small enterprise, must be, not a chief but a leader. His function is not so much to direct the change as to recruit a staff; to provide the necessary equipment and material, to maintain an atmosphere conducive to constant application, and to coordinate the work. The members of the staff are his associates, not his assistants.

The form of larger organization which has been most used in the past follows the lines of departmentalization. It necessitates arrangement for cooperation between
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departments on any problem involving more than one, something which is very easy to show in a diagram, but very difficult to obtain in practice. This system has the advantage of making it possible for the work in each branch of the enterprise, but carried to its logical end establishes artificial barriers which impede progress.

The organization around the process becomes then a question of fitting the arrangement to the workers available, deciding each case on the basis of its own peculiar conditions. It is entirely possible to obtain in one process harmonious and efficient work with the various sub-process organized in different ways; in one with workers of more or less independence of action responsible to a leader who is in turn responsible to the chief; in others with independent workers cooperating and each responsible to the chief for his part.

A military chief in planning a campaign provides means of transportation, and lines of communication to keep his troops supplied with ammunition. This branch of the service is secondary, but of the most vital importance. If it fails the campaign fails. Its function is to get ammunition to the fighting troops in sufficient quantities and at the time it is needed. The color of the trucks in which is brought is of less importance. It is of little comfort after the battle is lost for wants of shells to know that the records of the division are complete and accurate.

The clerical force of a innovative organization performs a similar function. Its function is not to establish channels through which the business of the unit must go regardless of consequences, but to provide ways of getting the ammunition to the front when it is needed. The official that has a blind adherence to records and regulation to obscure this end has outlived its usefulness.

The method of administering this service is a difficult one to arrange satisfactorily. The former method would seem to offer large opportunity for the exaggerated idea of the importance and authority which is the great evil of the service branches – the latter should enable the chief to make the clerical force what it should be, a servant to the process.

What has been said of the clerical force applies also to the IT, except that with few exceptions the IT people appreciate their relation to the process staff and any failure to function properly is usually due to faulty organization rather than to lack of inclination to be of assistance. The contact between the staff and IT people must necessarily be a close one. Nothing is more essential to efficiency that ready access to information. Data organization is not clerical work, but requires special training, knowledge of matter, and above all a wide acquaintance with business questions.

A third auxiliary branch which should not be overlooked is the mechanical shop. There are process whose time is more valuable than that of mechanics and it is not economy to allow work to wait for special apparatus or repairs. In a small enterprise the shop may be only a well equipped work bench; in some others the shop is really part of the unit, and should be complete and adequately manned. A week rarely passes in a enterprise that some small construction or repair job does no arise. The mechanical branch should be available to rake care of this work without unreasonable delay.

Some entrepreneurs do not continue their innovation works when they reach the applied stage because their tastes lead them to new paths in unexplored fields. In other cases the necessary equipment may not be available, or the branch of human activity to which the goods may apply not at hand.
Are Organisational Size and Efficiency Engaged?

The efficiency of many processes would be greatly increased if definite provisions could be made for carrying works to real completion without unnecessary delay.

Many processes which work well in small scale develop defects when tried on a large scale, and vice versa. Many methods of real value have never gotten beyond his scale, because there was no one with sufficient interest, or technical knowledge to adapt the process to the new scale. Thus there is a great economic loss which can be overcome by proper organization.

And, finally, to complete the work it is necessary to carry the goods to that part of the customers which is directly concerned. If it is something which affects established uses it is very difficult. The inertia of public cannot be overcome so easily.

If we should attempt to summarize these rambling observations in one sentence we would say that in promoting efficiency in innovation work, the essential thing is not the form and size of the organization, but rather the spirit in which it is applied. The organization should be like a roadway over which the innovative idea passes, not a structure in which is confined.

John A. Wheeler, who passed few months ago, says: “And as the surface of the planet becomes more and more densely covered with its human population, it become increasingly necessary to retain portions of it in a wild state, i. e., free from the organizing mania of men, as national and city parks or reservations to which we can escape during our holidays from the administrators, organizers and efficiency experts and everything they stand for, and return, to a nature that really understand the business of organization”.

Perhaps we can show a more apt illustration than Wheeler realized. The parks to which he was escape to allow his primordial instincts free play are possible only through an efficient organization. The forest through which he roamed unhindered had been saved from commercial exploitation by this organization; a fire warden in some isolated lookout station is watching for the first sign of the conflagration which his primitive instinct may had started, and a carefully organized and equipped firefighting force was waiting for the phone message saying that its services are needed at a certain spot; this organization stocks the streams with fish, protects the game, and constructs roads over which he could flee from the dreaded organizer; in short, it makes it possible to escape, as he expressed it, “from the organized routine of our existence”.

That conception of a park fits so well with our idea of a properly organized enterprise that we can say with Gratiano, “I thank thee for teaching me that world”.

OUR CONCLUSION

We believe there is not sufficient support to the thesis about the advantage of larger than small firms. And we remembered the words of Illya Prigogine (1997): “The little groups can give changes to society as a hole. Minorities had show remarkable power in the past. Thinking the change only succeed by majorities is wrong. It's wrong to think that conscious is determined by economic and social structures, and they are here now and ever. What will be tomorrow could be totally different from today”.
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Bishop, Kal (no date). *Creativity And Innovation - Large Firms Versus Small Firms*. http://www.statsheet.com/articles/article2302.html


NOTES

1 Of course, there are the opposite (Bishop).
2 Of course, there are the opposite (Bishop).
3 The constraints are most imposed by asymmetric information and capital market imperfections.
4 A character in Shakespeare’s “Merchant of Venice”.
TOWARDS A UNIFIED FIELD THEORY OF HUMAN BEHAVIOR:
GLOBAL CULTURAL EVOLUTION

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ABSTRACT
A model of human consciousness based on Earth's geologic history of mass-extinction & recovery (evolutionary dynamics). Five Earthly dynamics trigger within humanity's adaptive psychology an “adverse relationship” with environment – a Paradox that sparks human consciousness with intellectual and spiritual questions of unity vs. diversity (Earth/Mother vs. humanity). Humanity adaptively mirrors Earth's five evolutionary dynamics with five gender-based archetypes (bio-cultural dynamic) that unfold in a mythologizing of natural adversity as foundation for all human knowledge.

The intellectual lineage used to develop this model includes:
• Evolutionary biology and Earth systems science establish an overarching context for this study – answering Chalmers’ “hard question,”
• Paleoanthropology defines the circumstance of humanity’s emergence from Gaia,
• Psychology monitors humanity’s shift from animal-self to modern creative-self, using work of Hegel > Freud > Jung > Joseph Campbell > Arnold Mindell as a new structural psychology,
• Fractal geometry then offers a holographic design for modeling consciousness,
• Memetics, finally, presents a tool for measuring humanity’s conscious traits, with a variation of the Hall-Tonna values inventory.

This work presents a “general hypothesizing model” of human consciousness, in attempting a science of consciousness.

Keywords: human, global, culture, evolution, psychology, cognition, awareness, consciousness, archetype, myth, fractal, holographic, creativity, paradox, duality.

INTRODUCTION
I herein purpose a model for the study of human consciousness. This model focuses on human cultural evolution, with scant attention given to biological aspects. I do not offer a hypothesis, theory, or the like. Neither is this a research paper, nor a proof.

With a subject as grand as consciousness, and given its rather poor status within scientific understanding, the only standard one can possibly apply in a “model of consciousness” is a simplified measure of intuitive fit.

Science may be described as the art of systematic over-simplification.
Karl Popper, The Logic of Scientific Discovery
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Albert Einstein, with his famous “streetcar thought-experiment,” was a poster-boy for such modeling. He continually strove for proper intuitive fit, to first frame the problem, before proceeding to mathematical models. The goal of such a fit is to discover accessibility and utility with otherwise intractable problems (Silvert 2001). Such is the case here, as I attempt with human consciousness (hereafter: consciousness).

Everything should be made as simple as possible, but not one bit simpler.
Albert Einstein

In attempting a general model of consciousness, there are some basic matters to confront. First, are the many hurdles, abundantly discussed elsewhere (Tye 1995, Block 1997, Searle 1990), in developing such a model. For the sake of brevity, and as the point here is to transcend “insurmountable problems,” I eschew discussing these complaints, and simply present a model. Rather than explore these issues, I rely instead on the reader’s already established gestalt of such matters, and seek an intuitive reaction, as noted above.

Beyond the immediate problems of “a science of consciousness,” a second issue is perhaps of more import. That is: our reasons for studying consciousness. Of course, a motive is readily assumed, such as seeking some as-yet unrealized benefit for humanity. But of what exactly that benefit might be, one must be most careful. As example, repeated “eugenic errors,” “missionaries saving natives,” and naively engineered “pharmacological solutions” to necessary vagaries of consciousness, all inhabit our era.

Still, despite abundant, obvious, and well-versed snags to advancing an effective study of consciousness, none excuse us from the challenge of finding new ways to view this tough issue. So, with these few opening comments dispensed, I forthwith develop the model.

THE BACK-STORY OF EVOLUTION AND CONSCIOUSNESS

Evolution is the one theory that transcends all of biology. Any observation of a living system must ultimately be interpreted in the context of its evolution.
Martin Nowak, Evolutionary Dynamics, p. ix.

There is of course a long back-story preceding this modern question of consciousness. We perhaps know this story better as evolutionary biology, but with evolving consciousness necessarily parallel to evolving Life. Within this interoperation of Life and consciousness, a 3.5 billion-year filtering and sorting of organisms and systems, upon vast evolutionary landscapes, provides some basic parameters for framing consciousness. A schema of this evolutionary landscape, as currently understood, follows (Table 1).

First, and most obvious here, is that the aforementioned filtering and sorting deprives us of many comparative living examples to otherwise ease our grasp of how consciousness, and indeed Life, emerged and evolved. This presents significant informational voids in our understanding of these matters (e.g. so-called missing links, etc.).

Elimination of “deficient” competing systems is well known within evolutionary biology (natural selection) – but then this fact seems often ignored in many studies of consciousness. That is: consciousness in many ways appears to be treated as emerging and existing autonomously; as if separate from biology and natural selection. This of
course relates to Descartes’ well-known dualism (separation of body and mind), but also includes more recent versions like Chalmers’ “hard problem” (Chalmers 1998). ¹

Table 1.

<table>
<thead>
<tr>
<th>Progressively Complex Life Forms</th>
<th>First Appearance Millions of Years Ago (Ma)</th>
<th>&quot;Big Five&quot; Extinction Events and &quot;Others&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial (prokaryotic)</td>
<td>3,500 (primitive DNA)</td>
<td>Late Archaean: 2,600+</td>
</tr>
<tr>
<td>Complex cell (eukaryotic)</td>
<td>1,400 (1st common ancestor)</td>
<td>Early Proterozoic: 2,400</td>
</tr>
<tr>
<td>First multi-cellular animals</td>
<td>670 (&quot;Snowball Earth&quot;)</td>
<td>Precambrian ice age:</td>
</tr>
<tr>
<td>Shell-bearing animals</td>
<td>540</td>
<td>Late Cambrian: 488 Ma</td>
</tr>
<tr>
<td>Vertebrates (simple fishes)</td>
<td>490</td>
<td>End Ordovician: 440 Ma</td>
</tr>
<tr>
<td>Amphibians</td>
<td>350</td>
<td>Late Devonian: 360 Ma</td>
</tr>
<tr>
<td>Reptiles</td>
<td>310 (biggest mass extinction)</td>
<td>End Permian: 250 Ma</td>
</tr>
<tr>
<td>Mammals</td>
<td>200</td>
<td>End Triassic: 200 Ma</td>
</tr>
<tr>
<td>Nonhuman primates</td>
<td>60</td>
<td>End Cretaceous: 65 Ma</td>
</tr>
<tr>
<td>Earliest apes</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Earliest hominids</td>
<td>8</td>
<td>Würm glacial 0.10-</td>
</tr>
<tr>
<td>Homo sapiens</td>
<td>0.15 (150,000 years)</td>
<td>Holocene (modern era)</td>
</tr>
</tbody>
</table>

(Assembled from various standard texts on evolutionary biology, geology, and earth systems science.)

This possibility of “consciousness” as existing apart from evolving embodied organisms is clearly salient. But in this model, I look only at a specific embodied human lens. I test how far a “unified view” of consciousness can be developed, before resorting to ever-more abstract tactics. In the course of events, it is likely unavoidable to flirt with

¹ Chalmers’ work is ironic as it already points to an answer to his “hard problem.” “One might say an organism is conscious of an object in its environment when it can discriminate information about that object . . . and do something with it” – clear interoperation of consciousness and environment (consciousness as a “continuous” phenomena). But Chalmers never explores this environmental affect (natural selection), or the “something” consciousness is “doing with it.” Instead he waxes abstract on “redness as opposed to the quality of blueness . . . their similarities and differences . . . why they have their specific intrinsic natures [in our consciousness]” – qualia. This introduced abstraction tends to violate Occam’s razor, and suggests consciousness is somehow an autonomous phenomenon. Is it hard to imagine natural selection giving advantage to one who discerns “red ripe fruit” from “blue poisonous fruit?” A naturalist, anthropologist, biologist, etc. makes no such oversight (Attenborough 2002a). In Facing Up to the Problem of Consciousness (Chalmers 1995) he speaks of 1st person subjectivity and a vague “something it is like to be . . .” again ignoring natural selection, which acts in very subjective 1st person ways – survival or demise of the individual.
questions of such *dis-embodied consciousness* (mind, god, soul, etc.), but it is not “the mission” here.\(^2\)

**Second,** is the “stair-stepping” of more diverse and complex *Earthly Life* (left column, Table 1). Stair-stepping phenomena are quite obvious in evolutionary biology, with an implicit teleology of “more Life information.”

And while this *escalation of information* is central to most notions of evolution, this fact of evermore “living data” seems implausible, to some, as a coincident expression of consciousness — that is, consciousness existing mostly as a means of creating more Life information. This exclusionary perspective allows a further decoupling of consciousness from evolution, which I suggest is spurious, and presents a hard problem in consciousness (note 1).

The presented model argues that consciousness is deeply entwined in producing “more information” (teleological), coincident with evolutionary biology’s “more diverse and complex Life.” But to suggest consciousness simply emerges from the backdrop of Life, with humanity somehow exempt from evolutionary biology (autonomous), implies a *deus ex machina* — requiring yet another creation story, not yet named but postulated as a “hard problem.”

**Third** in this evolutionary back-story is that Life’s “stair-stepping” is achieved via iterative cycles of destruction and re-invention, both subtle and profound. “A thing” implicitly seen in the familiar phylogeny recapitulates ontogeny.

That mass-extinction and recovery is part of Earth’s natural biotic process is manifest in the “Big Five Extinction Events,” with some 20 total events speculated upon (right column, Table 1; Raup & Sepkoski 1982). But such “cyclic re-invention” also appears in natural selection – a daily spectrum ranging from extreme competition to inspired cooperation. Differences in such gross and subtle selection forces continually vary the evolutionary pressures seen by all organisms.

Without this heritage of recursive destruction and re-invention, the emergence of stair-stepping phenomena seems unlikely. That is to say, invention alone without destruction leaves no new raw material for *new information*. Invention in fact, survives only as destruction permits – a Life *Paradox* of: “creation,” paired with an inevitability of death in all things.\(^3\)

> *Remember that everything [living] adapted to the same invariant laws of the physical universe.*

\(^2\) *Non-human consciousness* can’t be studied without a full grasp of the *living human lens*, to first discern human artifacts from genuine encounters with anything we might regard as “other consciousness.”

\(^3\) This ties to entropy, the second law of thermodynamics. A need for such conflict in Life is noted by Schopenhauer, Nietzsche, Hegel, Sartre, and others; with each giving the matter different texture.
Fourth, for an organism to find its way across this 3.5 billion-year evolutionary landscape, it must have means of access and orientation. All organisms must *enduringly* capture information and material from Earth’s dynamic environments. Better access allows the organism greater evolutionary persistence and range. Organisms with relatively poor access perish, along with their particular form of “consciousness.”

This capacity for access is physically and behaviorally encoded. An organism’s capacity for such access, I label *general consciousness*. This is not far from what Chalmers says: “One might say an organism is conscious . . . when it can discriminate information about objects . . . and do something with it” (note 1).

Beyond this physical and behavioral encoding, *psychological dexterity* (defined later) further improves this general consciousness. “Dynamic access” then appears in many organisms, particularly humans, and serves as an enhanced “primitive antenna” by which one may navigate Earth’s dynamic landscapes. All organisms capable of such dynamic access (psychological dexterity) hold such an antenna.

It is this *composite primitive antenna* (physical, behavioral, and psychological) that I suggest is selected “for or against” in Life’s enduring evolutionary struggles. And it is this antenna, in this multilateral form, which is studied here as *consciousness*.

This *primitive antenna*’s specific traits drive the organism’s effectiveness in resource access, and efficiency in resource use. Without such antennae, recursively and directionally honed by eons of selection, evolutionary history would appear more as a “random walk” than a stair-stepped order.

With this basic understanding of “general consciousness as capacity for access,” a crude but effective base for the study of consciousness is established. Additionally, this typified notion of “general consciousness” leaves the work open to further comparative study of human consciousness, with other likely consciousnesses. But as noted earlier with *dis-embodied consciousness*, study of *other-embodied consciousness* is not the mission here. ⁴ Rather, it is humanity’s specific antenna that I examine in detail.

**A WORKING DEFINITION OF CONSCIOUSNESS**

From this now-summarized evolutionary back-story, I define this antenna of general consciousness as:

*An operating schema for spontaneous energy-matter exchange, which begets more information.*

Again, this seems not far removed from Chalmers’ earlier note, but with a key addition of “information.” This *realization of information* now becomes the “something” consciousness is “doing with its” environment (note 1). To further clarify these terms:

* spontaneous energy-matter exchange* – is access to and use of resource and information (energy release and capture) upon the evolutionary landscape, towards maintaining identifiable organisms and systems;

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⁴ Attention is given to comparisons and conflicts in consciousness, and other-consciousness in the full manuscript, as is the case for many topics introduced in this paper.
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- more information – is a byproduct of this exchange, where matter and information are converted from one form to another, with a frequent result (but not always) of “new information;”
- information – as a physical or abstract form, is anything intelligible to (further utilizable towards) an organism’s or system’s presence (persistence) upon the evolutionary landscape.

And, for operating schema, the basic form used here is (Figure 1):

![Figure 1](image)

... with an understanding that “Sub-Conscious” is a controversial term, which is later explained, as are the additional concepts of Social and Conscious Operation.

To define consciousness in these relatively simple and direct terms has an advantage. It allows the use of basic scientific and systems reasoning for the model. And with consciousness presented in this “Core triune” form, a simple mathematical design is rendered unto an otherwise elusive concept. But in this unadorned layout of “a type of triune consciousness,” no clear “human and other” differentiation is really possible. It offers no insight into how humans might contrast from rats, as conscious beings.

REFINING GENERAL CONSCIOUSNESS

To arrive at a model of consciousness that is both descriptive and explanatory of humanity, this simple form needs to expand. We must explore how this antenna is “improved and used” within and by humanity. To this end, I now enlarge this Core triune with additional information in multiple layers, externally and internally, as shown below (Figure 2). Those familiar with fractal geometry will quickly see that I develop a fractal model to expand the original form. Whether this structure grows via interior or exterior dimension is of little import as both have the same function in fractal geometry.

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5 Given here as a simple assertion, with analysis omitted for brevity. This is done, as some might say I argue an obvious point – except for the use of “sub-conscious” in place of “unconscious.” Development of this “Core triune” is presented in the full manuscript.
The first facet of the original triune I develop is *Social Operation*; to which I give three sub-facets of Memetic, Bio-energetic, and Economic Operation (Figure 3).

**Memetic:** anything seen as information, knowledge, tools, structures, or symbols passed from one generation to the next, and used in attempting to perpetuate humanity.

**Bio-energetic:** a direct physical ability to navigate the evolutionary landscape, access resources, and physically manipulate and transform resources, in perpetuating humanity.

**Economic:** intellectual and volitional command of resources (knowledge, goods, and services) upon the evolutionary landscape, whether achieved by competition, cooperation, autonomy, or other means.

The second aspect of the Core triune I develop is that of *Conscious Operation*, with sub-facets of Cognitive, Sensate, and Imaginal Operation (Figure 4).
Cognitive: analytic orientations of oneself in time, place, and circumstance, relative to events on the evolutionary landscape.
Sensate: all sensory input and output, including internal emotional and homeostatic operations.
Imaginal: association of possible events and outcomes (future) with one’s volitional acts and reactions (present), based upon one’s memory of realized events (past).

With the first two Core aspects just outlined, Social and Conscious Operation, the concepts used here are not unique. Nor is this their only possible presentation. As such, terms used here carry less weight than the framework in which they are placed – since a specific mathematical design is desired, one commensurate with these terms.

MAPPING A “SUB-CONSCIOUS MIND”
These first two triunes are derived from well-developed disciplines. This is not so for the third triune, Sub-Conscious Operation – more often called the unconscious mind. Modern concepts of unconscious mind, a virtual mare incognitum, give little clarity for modeling and studying consciousness (Table 2, Figure 5).

Table 2.

<table>
<thead>
<tr>
<th>Conscious Functions</th>
<th>Unconscious Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial</td>
<td>Massively Parallel</td>
</tr>
<tr>
<td>Self-Consistent</td>
<td>Massively Diverse</td>
</tr>
<tr>
<td>Limited Capacity</td>
<td>Huge Capacity</td>
</tr>
<tr>
<td>(finite percents)</td>
<td>(e.g., memory)</td>
</tr>
</tbody>
</table>

(Baars 2008)

6 These areas are later developed in “archetypal form” but generally refer to traditional disciplines such as sociology, economics, biology, kinesiology, semiotics, etc.
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*Ninety-eight percent of what the brain does is outside of conscious awareness. No one would disagree that virtually all our sensorimotor activities are unconsciously planned and executed.*


To attend the problem of an unstructured unconscious mind, which Baars and Gazzaniga point to above, I present a concept of human creativity as Sub-Conscious Operation. Others call this particular expressive aspect of humanity “the dynamically active part of the unconscious mind used in creativity.”

![Sub-Conscious?](image)

**Figure 5.**

In connecting creativity with Sub-Conscious Operation, I can then map the unconscious mind for “creative causal affects” in natural selection. By “creativity” I refer to a genesis of new information, as environmentally inspired within the psyche, regardless of how this information may manifest. In this linking of creativity with Sub-Conscious Operation, the unconscious mind is thus partly parsed for better form and language, to allow a formal study of consciousness.

*We begin by considering . . . that natural selection is a creative process. We then review its relationship to evolutionary change.*

*Robert Trivers, Social Evolution, p. 19.*

The term “sub-conscious” is oft criticized as too vague in meaning for scientific use. But it is precisely this vagueness that makes Sub-Conscious a perfect term. It mirrors the vagueness of knowledge, information, and temperament common to creative processes. As characterized before, “a thing” variously pointed to as: creative illness (Ellenberger 1970), mazeway resynthesis (Wallace 1956a), cultural revitalization movement

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7 “Sub-conscious” is a term most used by the lay public, and it is hard to find traditional academics willing to speak of anything but an “unconscious mind.” When I press such academics for a description of the creative process, such a phrase (as noted above) is typical. I use “sub-conscious” here, as its lay meaning generally fits my intended purpose, with literary economy.
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(Wallace1956b), sense-making (Weick 1995), and gestalt effect. All these concepts evoke chaotic traits, or “emergent behavior,”\(^8\) central in the development of complex integrative systems (chaos theory).

*The failure of the conventional approach to visual perception to address Gestalt issues of perception suggests current concepts of neural computation are inadequate, and that novel principles & mechanisms of perceptual computation remain to be discovered.*

*Steven Lehar, A New Gestalt Model.*

A major hurdle in mapping this Sub-Conscious creativity is a lack of comprehensive models for memory (WYNC 2007). To speculate on how memory performs in this creative role, I consider three factors: temporal breadth, depth of perspective, and dexterous association.

![Diagram](image)

**Figure 6.**

Temporal Breadth of Memory

As an evolutionary device, memory helps in locating resource-rich, or avoiding resource-scarce, environments (Figure 6). Within an organism’s map of environmental landscapes (abundant or scarce resources) the temporal breadth of that map affects resource access.

Organisms with memory “1 day wide,” recalling events only one day to the next, are unlikely to willfully feed on seasonal vegetal swings. But in volatile environments, where fluid adaptation helps, “limited breadth” is a survival handicap. Organisms with memories 1 week, 1 year, 1 decade, or even 1 century wide, have an advantage in recalling more methods, means, and sites for accessing food, shelter, etc.

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\(^8\) Novel and coherent tendencies and structures that arise during self-organization of complex systems.
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All creatures, large and small, are locked into the presentational spaces they hold.

*Michael Gazzaniga,* The Mind’s Past, p. 90.

Greater breadth of memory, gives a wider catalogue of environmental maps to antennae. And we can easily surmise that larger libraries inherently afford better access to important Life resources. This “library” concept certainly applies to the distributed machine intelligence and memory of our era, perhaps most notable today as the Internet.

**Depth of Perspective**

Second, as memories are encoded, each moment arrives as a cluster of experiences. Each memory exists as a “mini-complex” of simultaneous-coincident events and emotions. Every individual captures an impression of these events in his or her unique subjective sense of that moment.⁹

With differences in physical and mental ability, sensate acuity, and subliminal and emotional tendencies, “all” appears unique to the individual. Variance in personal experience is well known in trial law, as eyewitness accounts are notorious as the least reliable evidence given in court.

The particular “momentary spectrum” (depth of detail) any individual might capture defines their perspectival range. The more “aware” a person is in their *facultative bandwidth,* the more detailed information they gather for later recall. And accordingly, more information means more richly encoded antennae for better resource access.

**Dexterous Association**

Accompanying breadth and depth of memory, a third aspect can now be named – dexterity.

In exploiting evolutionary landscapes, our species has few purpose-built tools such as fangs and claws. Instead, we have an agile physical form that allows us to use rocks, sticks, etc. as pseudo fang and claw. In dexterously holding and manipulating rock and stick, we find tools for working the evolutionary landscape. It is a particular agility that in fact evolutionarily *demands* inventiveness of us!

*The freeing of the hands of the early hominids was a preadaptation that permitted the increase in tool use and the autocatalytic concomitants of mental evolution and predatory behavior. Autocatalytic reactions in living systems never expand to infinity. Biological parameters normally change in a rate-dependent manner to slow growth and eventually bring it to a halt. But almost miraculously, this has not yet happened in human evolution.*


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⁹ (WNYC 2005). This also appears in the work of Jean Piaget, but later (Schore 1994), and others – generally referred to as “affect regulation.”
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In the hands of early man, rock must somehow become missile, hand ax, nutcracker, hammer, etc. And stick must become back scratcher, fruit whacker, club, boomerang, fish spear, digging tool, and termite fisher. Individuals not making a dexterous behavioral association between their own physiology and the particular physical attributes offered by rock and stick, are clearly disadvantaged. They collect less fruit, prey, grubs, etc. But those who make this happy association find evermore inventiveness rewarded. Dexterous physicality – or rather, a lack of purpose-built fangs and claws – thus evokes, via necessity, an agile neuro-psychology, and “innovation” hence flourishes in survivors.

Integration of Memory Process Effects

Individual neuro-psychologies of varied dexterity then combine with memories of different depth and breadth, for a basic creative profile (Figure 7). This blending of memory’s diverse traits amplifies over time, and is further compounded with other learned associations. We spontaneously recombine “our libraries” in sleep dreams (unconscious introspection), daydreams (conscious introspection), child’s play, and in most anything we might call entertainment, art, sport, fantasy, or intellectual exercise.

![Figure 7](image)

This capacity for “recombinant creativity” is first evidenced in human artifacts of the Great Leap Forward – perhaps enabled by an emergence of mirror neurons (Ramachandran 2000). Artifacts of this creative onset grow in richness and complexity, mythically remixing Earth’s elements and creatures (sphinx, griffin), as our creative function builds momentum.

But these creative associations are not just crude, artistic, or fanciful. Early man associates and coordinates many of life’s diverse forms. Stick is not just spear and so forth, but also “floats in water,” “holds fire,” forms an “impenetrable thicket,” a “swing vine,” and on. And when man sees “stick twisted with rock” (roots), he associates stick and rock in an idea of “ax.” Ax is then even further recombined to yield battle-ax, pole ax, ice ax, fire ax, mattock, etc.

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10 Typically dated 90,000BP, but with much earlier “likely evidence.” Mirror neurons fire when an animal acts and when the animal observes similar acts performed by another, allowing imitation and learning.
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Our ability to discern specific traits in objects, retain those traits in memory, and to make associations amongst them (depth, breadth, and dexterity) endows a powerful evolutionary tool. It allows us to see a rock rolling downhill, convert this image to a wheel, recombine that wheel with other patterns, and then arrive at “new information” that stretches from wristwatch, to airplane, and to further untold horizons.

To capsulize the foregoing speculation on emergence of human creativity – what begins as basic genetic variability, reframed over eons, derives a certain dexterous physiology (human, hardware), which then calls for an agile neuro-psychology (mind, operating system) . . . that in turn demands certain “applications” (culture, software) to fully realize the physical vehicle’s potential value. But throughout, this “vehicle” remains intent on continuously improved energy matter exchanges, from necessity . . . as any lapse in this exchange will bring its demise upon the evolutionary landscape (selection, evolution).

This interleaving of “hardware, operating system, and software,” refined over millennia, regardless of whether its information is physically or abstractly encoded, allows human evolution, as we know it, to occur. Such a continuous process argues strongly for unified treatments of consciousness, over more divisive Cartesian mind/body views.

But then – evolutionary rates between gene and culture clearly differ, where culture is much more plastic than gene. This plainly suggests a legitimate “mind/ body split.” As a result, effective worldviews must take this into consideration. While this paper focuses principally on culture, this does not necessarily argue for such a separation of mind and body. The intent here is rather to argue for a well-reasoned integration of these important, although temporally distinct elements.

We are at least 5 million years separated from a common ancestor with the chimpanzees. Traits that differentiate us from chimpanzees have passed through at least 200,000 generations of selection. Most of the rapid increase in brain size took less than 100,000 generations . . . development of religion and art has probably experienced about 10,000 generations . . . By contrast, the last 10,000 years [not generations] have seen enormous changes in human life. Yet this time is too short for any but the strongest pressures to have produced much change.

Robert Trivers, Social Evolution, p. 29-30.

CREATING – THE DREAM FIELD

The spontaneous creative ability, just described above, I now develop further as a Dream Field (Figure 8). Dream Field points to a highly imaginative psyche, calling upon varied memory elements, in novel ways, to create new information. This concept is perhaps best typified by a general sense of Australian indigenous People’s “Dream Time” (Mindell 2000).¹¹

¹¹ Dream Field, as developed here, might be taken as rough kin to Global Workspace Theory (Baars 2008). Physicists Steven Weinberg also speaks to mythic aspects of “reality” as science in Dreams of a Final Theory, p. 46-7 (Weinberg 1992).
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This is why memories, dreams, and imagination are all the same process, for the mind uses the same interpretations whether it is dreaming at night, recollecting infancy, or imagining a new home . . . we experience the world the same way we remember it and dream about it.


In this Dream Field, all objects and beings have a dream life (encoded traits) we interact with in ordinary and non-ordinary reality. The Dream Field conveys all knowledge, thoughts, feelings, and impulses as imaginal/ dreaming elements that organically arise to sustain evolution. In fact: human evolution as creativity emerging from (or as) consciousness – a seemingly “spirit infused” (inspired phantom) like primitive antenna.¹²

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¹² An “inspired phantom,” perhaps related to Chalmers’ vague “something it is like to be . . .” (note 1) but also pointing to a human need for belief systems. This “need for belief” is better seen as requisite faith in our ability to creatively advance energy-matter access. Without a “community of shared myths,” as base, no generally agreeable sense of “knowledge,” or “science” (abstraction, culture) is even plausible. When we can no longer reasonably believe in our creative capacity (or “myths”), we would have then achieved an evolutionary terminus, a realized “animal maximum ability” (McNeil 1982). All further evolution must then come through genetics and a grim reality of brutal natural selection. This perhaps explains the persistence of “war” – our species’ lack of natural predators, then stirring a genetic disposition to self-predation when cultural access is weak. “Need for belief” is also noted by Nietzsche (in The Gay Science), by Freud (*Moses and Monotheism*), and modern writers such as Daniel Dennett (*Breaking the Spell*), Bruce Lipton (*Biology of Belief*), Andrew Newberg (*Why God Won’t Go Away*), and Donald Brown (*Human Universals*).
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The Dream Field gives rise to, and sustains, a variety of Platonic Forms, Jungian archetypes, and other meta-figures recombined from humanity’s early roots. To some, such “dreaming” may seem an odd concept to propose in “attempting a science of consciousness.” But associations between “the dream” and an appropriate environmental context lend substance to this otherwise turbid notion.

In making this human propensity for dreaming “present in time,” its evolutionary utility can be gauged by natural selection. So typically, only “effective fantasy dispositions” will survive. In these surviving fantasies we might then learn to associate:

- environmental abundance, scarcity, and neutrality with . . .
- population growth, decline, and no-change; and further, with . . .
- fantasy operation of high-dreaming, low dreaming, and middle dreaming.13

Our civilization . . . has not yet fully recovered from the shock of its birth - the transition from the tribal or 'closed society', with its submission to magical forces, to the 'open society' which sets free the critical powers of man.

*Karl Popper*

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13 High & low dreaming is a concept taken from lectures of Arnold Mindell, but significantly expanded herein. Marshak & Katz 1999, also look at similar triune “dreaming.”

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dullness – eventually arriving at effective evolutionarily outlets, as perhaps some kind of well-balanced synesthesia.\textsuperscript{14}

I would now collapse memory (maps of the evolutionary landscape) with imagination (real-time use of these maps) to yield “Sub-Conscious Operation as a creative function” (Figure 9).

This combining of memory and imagination to frame creativity, also suggests a mechanism for meme generation and maintenance (Figure 10). As organisms wander the evolutionary landscape, memetic encoding comes to reflect that organism’s composite facultative bandwidth (competence) in interacting with its environment. Individuals with a skilled grasp of their sub-conscious processes, balanced with an equal grasp of conscious and social processes (i.e. highly intuitive), would seem to have greater bandwidth.\textsuperscript{15} In fact it is just such a longing for this implied deep intra-subjective dialogue of disparate psychological parts (tension) that consumes many artists in the midst of their “creations” (Csikszentmihalyi 1996).

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\textbf{Figure 10.}

\textit{Today the function of the artist is to bring imagination to science and science to imagination, where they meet, in the myth.}

\textit{Cyril Connolly}

Those memetic seeds born of this creative process, and which survive, then carry on to influence language and symbol development, personal and social values. And if the

\begin{itemize}
  \item \textbf{Apophenia:} abnormal meaningfulness, seeing patterns or connections in random or meaningless data.
  \item \textbf{Synesthesia:} cross-sensory experiences often associated with the creative processes of artists, writers, etc.
  \item Regulation is achieved via emotions (figure previous page) and points to work of Antonio Damasio 2003.
  \item \textsuperscript{14} “Intuition” might evidence an advance in one’s “theory of mind,” for self and other. Such “intuitive” intellectual plasticity is cross-cultural, and appears as a type of “shamanic shape shifting” (focused empathic acts) in modern and early man. Attenborough 2002b shows this clearly with !Kung San peoples, and in a similarity of tracking skills between early and modern hunters.
\end{itemize}
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organism sees enough survival utility in a given meme, that meme then persists as a full-formed reified abstraction. Memes find a life of their own within human culture, serving as “the gene” of cultural evolution; reflecting our species’ collective bandwidth for environmental competence. Memes grow, are pruned, bud, branch, and become extinct, reflecting a species collective awareness – again showing a “leaderless” emergent behavior (Blackmore 2000).16

With this model of Sub-Conscious Operation now nearly complete, a more synergistic view of consciousness, as a somewhat whole thing, is presently possible. This map points to a richness of human culture beyond the earlier simple Core triune illustration of Social, Conscious, and Sub-Conscious Operation.

This design also serves as a type of evolutionary kaleidoscope (Figure 11), with different facets aligning – as ability, circumstance, and environment require. Such a map of course does not define all of the unconscious mind, and leaves much space for other concepts of mind, god, spirits, morphic resonance, competing systems, and the like. As William James once put it (James 1892): “The attempt at introspective analysis in these cases is in fact like seizing a spinning top to catch its motion, or trying to turn up the gas quickly enough to see how the darkness looks.” But in placing these “conscious elements” within a fractal model, our subject matter is not suddenly robbed of all dynamism or mystery.

Further, this fractal map allows for mythic profiling. The Greco-Roman pantheon of gods and myths can be easily plotted: Sisyphus for low dreaming; Icarus for high dreaming; Vulcan or Prometheus for Bio-Energetic; Venus, Bacchus and Pan for Sensate; Croesus or Midas for Economic; etc. With this mythic facet now added to the cultural, psychological, and mathematical features already shown, we find an ever-more complete and richer model for consciousness.

Figure 11.

This model points to a likelihood of unified structures for consciousness in several ways:

16 Absence of true “leaders” is another emergent trait, note 8.
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- Jung strongly argued against any formal structure for the unconscious mind, as this would destroy its creative role. This unstructured view rather defeats Jungian psychology as a science, while more structured behaviorist and Freudian views prevail. But in this new model we now have structure and creativity, which neither Freudsians nor behaviorists address (Davis 2003).

- Levi-Strauss saw myth as a universal human language (as did Jung, Joseph Campbell, and Freud). Much of his later work attempts to define a topology for this imaginative function, which the proposed model now presents (Buchler 1968).

- With meme generation and maintenance now given a formal order, cognitive testing of consciousness (via Hall-Tonna values mapping) is plausible, along with a later promise of possible predictive models (Hall 1994). Further likely “testing tie-ins” also appear between Browne’s anthropology of human universals and the Hall-Tonna values map (Brown 1991).

- Damasio’s work with emotions suggests structural consciousness as having core and extended facets, which this model echoes (Damasio 2000s). This structural split of core and external elements also appears in anthropologist Adlof Bastian’s Elementargedanke (elementary ideas) and Gesellschaftsgedanken (folk ideas), which led directly to Jung’s theory of archetypes, also used by Joseph Campbell (Campbell 1959).

- David Bohm and Karl Pribram speak of a holographic cosmos and a holographic brain, predicting the mathematical design used in this model (Talbot 1991). And with a cultural hologram herein presented, it now seems possible to plug an implied Bohm-Pribram “cosmology-neurology gap.” Similar holographic explorations might then lead to further expansion of unified perspectives across multiple disciplines.

- Finally, the proposed model conforms to Steven Pinker’s five ideas for a new “computational theory of mind” (Pinker 2002). Those ideas being:
  - the mental world can be grounded in the physical world by concepts of information, computation, and feedback;
  - the mind is not a “blank slate”;  
  - finite combinatorial programs in the mind generate an infinite range of behavior; 
  - universal mental mechanisms underlie superficial cultural variations; 
  - and, the mind is a complex system of many interacting parts.

Realizing – The Dream Field

With this basic psychological map in hand, we can now move on to a physically realized human culture. At birth, already, we transcribe these archetypal forms onto physical kin relations (and vice versa – Figure 12).

We populate this template with living characters, while these same characters refine the psychological patterns of our nascent world. As vulnerable and impressionable infants, kinship provides for our needs (conscious, sub-conscious, and social) via physical and emotional paths. But these physically realized archetypes of kinship quickly expand as we grow, gain perspective, and enter tribal life. In the tribe, with all inhabitants still personally known to us, our realized map of individual characters and traits swells.
These physical-ized maps then inflate further yet as we “intellectually” move beyond kin and tribe. Clans and guilds appear on distant horizons as our species fills new terrains (Figure 13). We may not directly know these new members, but we readily accept them “as real as” anyone we do know. Still, our knowledge of these increasingly diverse individuals is now second-hand, abstracted. This “abstract quality” also shows in the skills, languages, and resources these distant clans and guilds use, control, and represent (knowledge, expertise, trades, goods).

Beyond the original realized archetypes of kin and tribe, early reified archetypes, as a new informational form, now emerge from our encounters with clan and guild. Early

17 Terms and relationships implied here as kinship, only show one of many legitimate possible views.
“intellect,” and other abstractions arise in adventurous parables of the tribe’s warriors, adventurers, and traders wandering strange lands. New information (and energy matter potential) abounds in the arrival of rare goods, exotic prey, wounded or dead combatants, strange captives, and terrifying invaders... all retold as storied “tactics, strategies, and lessons” around a campfire. Drama (life/death) from these stories fills our attention, and we readily forget the “story’s role” is only secondary to an ultimate quest of simply meeting Life’s hard demands of energy matter exchange – as much to escape Life’s terror/ tedium, as anything else.  

Drama and story come to embody a rich, dense, multi-layered “informational encoding” readily passed across generations (Campbell 1949). Each individual within the tribe naturally focuses upon specific narrative elements most relevant to their own life, while ignoring other facets the story offers.

What I now call a three-part psychological/ realized/ reified archetypal map (Figure 14) then expands and contracts, as populations rise, fall, and shift. Human drama drives us through various cultural phases, and across years of tribulation. But, eventually we arrive at a view of the whole of humanity, in its full complexity (globalization). This sketch of the human journey obviously condenses and oversimplifies much of what occurs in real life, but still well illustrates the model. And as before, terms used here, while important, are ultimately not as crucial as the mathematical design we craft.

In this expanded global map, we now find a holographic view. The triune form that resides at the center (Core/Mythic), also defines each habitant, individual, and system at

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18 The Eternal Struggle, constructive confrontational Paradox, notes 3 and 12. A life of much tedium, punctuated with terror; Drama then becomes a “rehearsal” for real Life terror (selection or elimination). 
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the periphery, and at all points between. This portends a “center of consciousness” as residing everywhere and nowhere, a dynamic “center-less” form, again pointing to ever-emergent behavior. These evolving constituents and variables are plotted above (Figure 14).

Their roots may be looked upon as of immediate psychological interest to us all. The archetypes live in their realm, beyond time and space. This builds the bridge of understanding between men of all ages, and makes it possible to realize that we ourselves with our essential problems are bound up in the continuity of the eternal problems of mankind, as they are mirrored in myths. But the form in which the archetypes appear, their garments so to speak, depend on the historical conditions: the symbols in which they appear change.

Rivkah Kluger, The Gilgamesh Epic.

As typical to chaos theory modeling, we start with a simple figure, a “Seed of Consciousness” (general consciousness), which is then elaborated with self-similar iterating forms (Figure 14 & 15). The resulting “mandala of consciousness” profiles just one generation – a snapshot of human-evolution. It is easy to then expand this model in considering generation upon generation of unique human contributions. “Old information” endlessly remixed and iterated to give “new patterns” – a ceaseless emergence of more Life information (diversity and complexity).

The “Seed of Consciousness”

With each generation, the “mandala” takes different shape; reflecting events that precede it, the varied growth of individuals within, and Life’s momentary pressures. This mandala is shown here as neat rings of equilateral triunes, yielding a mere single concentric shape with a clear center. But everyday dynamic imbalances drive each facet
within the mandala to take very unbalanced forms. A resulting cultural “amoeba-like” profile better typifies Life’s reality, more than any circular form used here, but then such “cultural globs” do not render easy presentation of an already complex model.

To simply call this view “holographic consciousness” does not seem adequate. The iterative and emergent dynamics pictured here really call for more descriptive names. Notions of “coapt” or “aliquot” modeling seem perhaps more appropriate, but are also unsatisfying.

*Our aim is to establish the human kingdom as a pattern of values distinct from the material world. Contrary to the philosophy of Descartes, and of Kant, we are discovering in the cogito not just ourselves but all others. Thus we find ourselves in a world of "inter-subjectivity" where man has to decide what he is and what others are. Jean-Paul Sartre, Existentialism is a Humanism.*

**SO WHAT!? – REAL WORLD RELEVANCE**

What I’ve developed so far may seem little more than a novel psychological/mathematical view. “Real World” relevance is likely not yet evident. The utility of such a model as this is perhaps best evinced as a “reified epistemological map.”

In mapping this real-world relevance, I begin with an element common to all of natural selection – *environment*. In a certain sense, environmental concepts of *abundance, scarcity, and neutrality* seems to be a reasonable baseline worldview – for all species. If this is indeed the case, we already begin “evolutionarily” with a simple triune form we can further elaborate in the following four categories:

<table>
<thead>
<tr>
<th>Environment</th>
<th>Physiology</th>
<th>Psycho/Spiritual</th>
<th>Memetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scarcity</td>
<td>Reptilian</td>
<td>Freud</td>
<td>Daily Life</td>
</tr>
<tr>
<td>Neutrality</td>
<td>Mammalian</td>
<td>Gurdjieff</td>
<td>Mythic</td>
</tr>
<tr>
<td>Abundance</td>
<td>Neocortex</td>
<td>Hegel</td>
<td>Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Holy Trinity</td>
<td>Religion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oedipus</td>
<td></td>
</tr>
</tbody>
</table>

To develop this elaboration, we might “imagine” an association between our triune worldview, with certain implied “states of existence,” and a triune brain structure (MacLean 1990):

- Scarcity > *Survival* > *Reptilian*
- Neutrality > *Social* > *Mammalian*
- Abundance > *Creative* > *Neocortex*

To be sure, reptilian, mammalian, and Neocortex, is not the only neurological triune we might use (Singer 2008). And, equally important is that this obviously is not the only way to visualize brain structure and commonly associated states of existence – as bilateral/bicameral (right-left) brain models, and other more fine-grained views, are also evident.

But we can easily extend this triune relationship between environment, existential states, and physiology, to now include psychology, reasoning, and spirituality. Here we meet
Freud’s famous “id, ego, superego,” and Gurdjieff’s “emotion, instinct, intellect.” And there is of course Hegelian dialectics of “thesis, antithesis, synthesis,” as yet another close alliance.

Perhaps more famous is the Catholic “holy trinity – father, son, holy ghost.” And a similar order appears as “father, son, mother” in Sophocles’ Oedipus trilogy (with a Sphinx’s three-part riddle). In his Poetics, Aristotle cited Sophocles’ trilogy as having perfect (three-part) structure, viz. peripeteia, anagnorisis, and catharsis. When we look beyond these basic structures to more common memetic models, further triune forms simply burst forth:

- **Temporal Sense** – past, present, future
- **Physical Dimension** – height, width, depth
- **Mythic (storyteller’s rule of 3)** – 3 wishes, 3 little pigs, bears, brothers, sisters
- **Medicine**: causes of all illness – environment, genetic, pathogens
- **Education**: states of learning – cognitive, associative, autonomous
- **Evolution**: forces of natural selection – purifying, directional, divisive
- **Information Theory** – data storage, retrieval, transmission

(And many, many more.)

To answer the earlier question of “Real-World Relevance?” – this model appears to span humanity’s entire experience of Life. Reaching across environment, physiology, psychology, reasoning, religion, and the memetic . . . a full human continuum is thus mapped. But clearly this does not suggest our only means for modeling information, nor does it claim a conclusive “scientific approach” is now suddenly in hand. Much work remains before attempting such claims.

> Whenever a theory appears to you as the only possible one, take this as a sign that you have neither understood the theory nor the problem it was intended to solve.
> Karl Popper

**ORDERS OF COMPLEXITY**

Overall, this “global holographic” map only suggests an order of complexity in our ways of creating, using, and managing information. It speculates on humanity’s creation of informational paradigms and devices – an epistemological map, if you will, of “the thing” we might call consciousness.

As example of such an informational paradigm in operation, over the course of our 3.5 billion-year evolutionary landscapes, one thing is certain. Most all organisms now have a strong sense of self-importance, a dividend of survival, as it were. But this need for healthy narcissism now also appears in infinitely more complex social propositions amongst humans. In fact, such narcissism continually evolves towards broader and richer expressions of socially enlightened self-interest (i.e. love, compassion, etc.) . . . or so it seems “we might hope” (Csikszentmihalyi 2006).

> There is no reason to believe during this final sprint [recent evolution] there is a cessation in the evolution of either mental capacity or the predilection toward
special social behaviors . . . substantial changes can occur in the span of less than 100 generations . . . Aggressiveness was constrained and the old forms of overt primate dominance were replaced by more complex social skills.
Edward O. Wilson, Sociobiology, p. 569.

Primitive narcissistic awareness must certainly be seen as any organism’s “true first order” (fear, survival) for effective information management to even exist. But pure narcissistic survival strategies are severely pathologized today amongst humans – even though they were, and may yet be, a rather weighty factor in survival.

Natural selection is the morally indifferent process in which the most effective replicators out-reproduce the alternatives and come to prevail in a population. The selected genes will therefore be the “selfish” ones . . . An [successful] adaptation is anything brought about by the genes that helps them fulfill this metaphorical obsession, whether or not it also fulfills [personal] human aspirations.
Steven Pinker, The Blank Slate, p. 53.

But then a shift in our reasoning somehow occurs – we move towards something more complex, the social. Beyond first order narcissism a second order awareness arises when basic survival is no longer a perpetual crisis. Incipient “excess resources” eventually allow time for reflection and the gathering of secondary information (curiosity, creativity).

This repose of abundance clearly appears in our first agrarian societies. But then “second order tenets” also surface in our earliest subject-object relationships - the participation mystique, an infant’s traumatic separation from its unitary amniotic environment, induced to mother’s “love” . . . prompting the early discovery of an archetype for all future anxieties (Grof 2000).

In Western philosophy, such analytic separation as a necessary element of consciousness is noted by Heraclitus (500 BCE), expanded by Christian mystic Jakob Böhme (1600’s), later by Hegel (1700’s), and then Nietzsche (1800’s). Finally, anthropologist Claude Levi-Strauss uses “duality” as keystone in developing Structural Anthropology.

But this “dualistic consciousness” is noted even earlier in Eastern Taoism (600 BCE) and Zoroastrianism (1600? BCE); first dawning of what German philosopher Karl Jaspers calls the Axial Age. Regardless of its lineage, modern world examples still abound for “second order” reasoning. They appear as President Bush’s pronouncement “you are with us or against us” in his invasion of Iraq. They entertain us as the bombastics of “conservative” talk-show hosts, and the like. Introvert/ extrovert, intuitive/ didactic, god/ demon, hero/ villain, either/ or – all are common to our already deepening sense of social expression and responsibility.

Duality in consciousness perhaps first arises neurologically, as couched in our bi-lateralized (right-left) brain functions, Julian Jaynes’ bicameral mind, or even in our obvious sexual dimorphism. A state of “thinking and being,” in many forms, that allows us to argue with ourselves; a type of formative pseudo-schizophrenia that perhaps
matures over time as an exploration of “the Self” and “Other.” This also points, of course, to Martin Buber’s *Ich und Du* (as translated, *I and Thou*), similarly developed as Ich-Es (self-object) (Buber 1996).


Deepening dialogues on humanity’s “perspectival ponderings,” of similar stripe have since followed – *Sphereland* (Burger 1983), *Spaceland* (Rucker 2003), *Flatterland* (Stewart 2002), *The New Flatlanders* (Middleton 2007). All with a recurring theme of endless struggles to find “a right” paradigm fit to Life’s diverse evolutionary challenges. These third order paradigms unfold as already detailed above.

With this shift to a third-order paradigm, such a 1-2-3 progression points to as-yet undefined futures. But by definition, “this future” lacks a body of work and language for easy discussion – it remains to be invented. It lies beyond the “normative zone” in which we comfortably work and live (Figure 16). Matters outside our usual range, often we demean, pathologize, or simply dismiss.
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Most of us live in cultures that discourage introspection and emotional closeness, particularly in work. We engage in social rituals, roles, and pretense with each other rather than expressing experiences openly and deeply. Rituals, roles, and pretense are social walls that stop us knowing ourselves, and one another, at deep levels.

Gary Gemmill, The Dynamics of Having Nothing to Say in Small Groups.

This is certainly the case with first-order narcissism, and with later “touchy-feely” or “new age” fourth and fifth order paradigm developments. We remain mostly focused on second and third order reasoning, with frequent narcissistic bouts. Even with our most progressive “practitioners of consciousness,” almost any early practice of these later paradigms seems mawkish, confused, and uncomfortable. Again, a presence of emergent behavior. Examples of such complex, late order paradigms certainly do exist, but unfortunately they offer little to the current scientific dialogue, except for with the most visionary of individuals.

Our knowledge can only be finite, while our ignorance must necessarily be infinite.

Karl Popper

To summarize humanity’s unfolding of complex reasoning (paradigm development), the illustration above is a useful capsule. Despite this figure’s depiction of predominately upward trends, a potential for “systemic collapse” must be held always open, as acute environmental shift may demand at any time. Regardless of what paradigm we momentarily embrace, constraints of the macro-environment continue to hold sway.

Figure 17.

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19 Meditators, nuns, monks, yogis, artists, and most any esthete seem to require separation from influences of established paradigms (daily life), to manifest or appreciate elements of likely later paradigms.

20 Mostly referring to work of Andrew Cohen, Ken Wilber, and compatriots. Other efforts wax and wane, such as “Humanism,” “Non-Violent Communication,” “Power Equity Groups,” “T-Groups,” etc. But sustained momentum of Cohen and Wilber’s work currently seems to support an incipient paradigm shift.

21 This spiral figure also points to work of Clare Graves 2005 and “Spiral Dynamics,” as developed by Chris Cowan, Don Beck, and used in work of Cohen, and Wilber (note 20).
Further, in reconciling this “neat spiral” to Life’s dynamic reality, as with the earlier noted mandala, this spiral too is driven to very unbalanced forms. And, as a holographic figure, “emergent centers” can seed new generational mandalas at most any point(s) and precipitate new evolutionary threads. Dynamics of complex vining, budding, branching, and extinctions flourish (Figure 17). Andy Clark coins the term “Escher Spaghetti,” which seems most appropriate as an ultimate expression for this figure now shown as a neat spiral (Clark 1999).

Beyond this “Escher Spaghetti,” yet other complex layers arise. I already mentioned a “normative zone,” but even this is oversimplified. With the “center of consciousness” residing nowhere as well as everywhere, a true singular normative zone simply doesn’t exist. Depending on how ambitiously one directs their attention, a “normative range” in fact exists for every individual, community, culture, state, species, etc. (Figure 18).

The challenge of existing within such a diverse reality is to then consider the intellectual and emotional plasticity needed to grasp a cluster of divergent points (individuation), understand the position of each point (compassion), and skillfully bridge the interstitial spaces between these points (love) . . . all as a means of utilizing a system’s distributed intelligence (the capture of entropic “free energy”).

While language used here begins to verge on 4th-5th order new-age-y-ness, this matter of “bridging” lies at the heart of every modern businessman and woman’s, and every politician’s mission. The question then remains: “How is this done effectively and efficiently?” To answer this question requires an exploration of elements shown above as IQ and EQ . . . but then this also begins to exceed the paper’s original goal of “simply presenting a model.” And so, I end here.
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SUMMARY

With a subject as broad as consciousness, much is inevitably left unsaid in a paper of any length. Material herein is parsed from a larger manuscript. To capsulize what this general model depicts however, the figure below is perhaps useful (Figure 19).

What this model proposes, in a simple triune form, is a means by which humanity extends itself into the cosmos. Through our use and advance (complexification) of Conscious, Subconscious, and Social Operations, a collective of “human consciousness” confronts, captures, and metabolizes energy and matter upon the evolutionary landscape.

In this “extension of consciousness,” humanity thus attacks the grim reality of Life’s endless Chaos-Entropy and excretes Information. And in this excretion of Information, propels itself across the landscape. Humanity then wanders Earth in an eternal search for unique Life mandates . . . continually seeking “What does it mean, to be human?” This exploration is our single most enduring adventure of “self-awareness, and self-realization.”

![Figure 19](image)

While this model offers an epistemological map by which we might answer such a question, it neither posits nor assumes an answer, and is mostly non-teleological. Instead, ironically, it suggests a mechanism for just how such teleology is realized.

A map such as this is easily improved by ontological maps of Life, a unified field theory in physics, or better neurological maps – yet none exist. Perhaps of even more immediate interest: it is one thing to propose a mathematical design, but what of specific mathematical terms? How do these terms relate to any testing methodology we might use, or predictions we create? And, can we even pretend to test something like a “Sub-
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Conscious” mind? If a predictive model is achievable, do we even really want one? Eugenics would certainly raise its head from a nest of rather unpleasant ethical dilemmas.

Of what is presented here, much more can be added but is necessarily omitted. Fourth and fifth order paradigms are only superficially mentioned. The original of this paper notes five “evolutionary dynamics” yet only three are explored here. And gender is never addressed, but must certainly be expounded.

The principal “eternal conflict” (Figure 20) of Life/Death, Feminine/Masculine, with its many faces – a Sacred Wound – if you will, is scarcely touched. To delve deeply into the ever-cryptic facets of this Core triune is needed to grasp the “emergent mentation” (seeding of new evolutionary threads) typical to humanity’s enduring struggles.

![Figure 20.](image)

When we begin to trip over such thresholds of 4th and 5th paradigm awareness, eyes are tempted to roll up in one’s head, or at the least to “glaze over.” Still, how is this skillfully done? Do we begin to speak of “infinitely unfolding relationships,” “of “aboutness,” “becomingness,” “suchness” and the like? Our language, grasp, openness, and wherewithal to such matters leave much to be desired.

Despite this brief presentation, I trust enough is conveyed to stimulate useful thought and discussion. Work like this demands further true cross-discipline efforts, well beyond the keen of any individual or specialty.

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INFORMING THE CONSUMER IS STRENGTHENING THE ECONOMY

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ABSTRACT

Adam Smith’s assumption that consumers are rational and knowledgeable in their buying decisions is examined in this paper, along with the views of other prominent economists. It is concluded that this assumption is incorrect, though consumers are clearly somewhat rational and knowledgeable. The detrimental effects of the lack of consumer product knowledge are thus recognized in a few scenarios as examples.

Although, this would be a very valid conclusion for this paper, the paper follows this topic of Smith’s faulty assumption for the purpose of making improvements of our economic system. The conclusion that organizing to enlighten consumers can correct for Smith’s faulty assumption is proposed as a solution to many of the inequalities of our present free market system. Some details on the effective way to organize for consumers are mentioned.

Keywords: Consumerism, economics, information economy, corruption.

A VERY SHORT HISTORY OF ECONOMICS

What would Adam Smith think of economics today?

There is a Presidential election on the horizon this year. People from many different perspectives are taking positions on economic policies. Consistently, they refer to theories proposed by now famous economists such as Adam Smith [North, 1995], Karl Marx [Britannica,2008], John Maynard Keynes [Kangas, 2008], and Milton Friedman [Wikipedia, 2008]. I believe that these theorists were more in agreement than disagreement, and that they are largely misunderstood in this regard. All of them are social scientists, who have dedicated their minds to the scientific method and applying it to economics. As a rule, economics is a social science, in which we are attempting to predict the behavior of people. People by nature are very complicated and somewhat unpredictable. So, in the realm of social sciences it is necessary to predict behavior by averaging in order to be able to generalize at all. Sometimes, we are unable to explain generalized patterns of behavior, and other times we can only do so by analyzing scenarios of human behavior. In economics, we are usually analyzing scenarios in the marketplace. The science itself was born out of the work of Adam Smith in his book, “The Wealth of Nations.” For the most part, economists since Smith have not disagreed
Informing The Consumer Is Strengthening The Economy

with him. They have mostly improved upon his theories and interpreted them in different ways. That is one of the purposes of this paper.

One of Adam Smith’s assumptions, in making his theory of supply and demand, was that people are knowledgeable as to the value and overall impact of their buying decisions. This assumption was a necessary premise to his understanding of how free markets use prices to properly allocate resources, and direct economic activity to be more efficient and productive. According to his theory interfering with the free market interferes with the efficiency of the economy and has many other deleterious effects.

Other Economists Improve on Adam Smith’s Theories.

Other prominent economists after him, like Karl Marx and John Maynard Keynes, would find this free market system susceptible to many kinds of problems. In Marx’s times, the free market system created large fluctuations of unemployment and work force dislocation that resulted in instability to the general economy. Also in Karl Marx’s times workers often received subsistence, or below subsistence wages, and suffered unhealthy working conditions. This was crucial to understanding Marx’s surplus value theory.

According to Marx, the capitalist charged a surplus value for manufactured goods, above his costs and a fair return for his efforts. He was able to do this because he was in a more powerful negotiating position than the worker or the buyer of his products. The powerful negotiating position he enjoyed allowed him to offer subsistence wages, because the worker might not have any other option than working under such conditions. Capitalists could, on the other hand, offer these positions to many workers. To clarify, this is not to say that the worker didn’t have any leverage in choosing one job over another. It was just that the capitalist usually had more leverage because he could chose between many workers, especially when the unemployment cycle resulted in many desperate workers. This is related to the reasoning behind outlawing monopolies. The capitalist, who is the only provider of a certain product, has so much negotiating power from his position that the free market pricing system can not function.

John Maynard Keynes was well read in both Marx and Smith, but he had perspective to add to this conceptualization of economics. Keynes understood how the business cycle leads to suffering and economic instability. In his studies he even invented the study of macroeconomics. But, he was not satisfied with understanding it; he was concerned with solving the problems of the great depression. Unlike Marx, Keynes didn’t believe in Marx’s simplistic solution to this problem, namely communism. So, he came up with adjustments to the free market system, based on comparisons with socialist economic systems. It would include raising government spending, while lowering taxes in times of economic recession, and lowering government spending, while raising taxes during economic expansion and inflation. As always seems to be the case, political leaders would misunderstand these applications of Keynesian theory, resulting in misguided economic policies.
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*A Renewed Belief in Free Market Economics*

It would not be until much later, though, that politicians would change their misguided policies for a very opposite approach, based on the theories proposed by economists like Milton Friedman. Friedman elaborated in many different situations, how government intervention into the pricing mechanisms of the free market consistently made for less efficient and productive economies. Although this was consistent with Keynesian economic theory on the whole, in details it differed. It also resulted in different economic policies by those politicians that would attempt to understand those theories. Many of the Western democracies would implement campaigns of privatization of the economy. One country after another went from using large state run companies to manage certain types of industries, to selling them off to private interests. Going along with Milton Friedman’s approach, many countries began deregulating their economies as well.

**IMPROVING ON ECONOMICS BY REALLY USING ECONOMICS**

*What Would Milton Friedman Think of Deregulation’s Latest Effects?*

It is impossible to know for sure if Milton Friedman would have agreed to the type of deregulation that has been happening in recent years in his native United States of America. Many blatant environmental and human rights abuses, among other types of abuses, have occurred as a result of the lack of regulation. Maybe Friedman would have pointed to the corruption of big government as the root cause of the problem, or maybe he would have recognized a limited role of government to regulate in some areas. Nonetheless, a political debate has ensued with one side proposing more protection through regulation, and the opposite side proposing less regulation for a more productive economy, at the expense of allowing more abuses of the system [Yasumoto, 2000]. At present financial analysts can actually calculate an estimated cost of regulations, and other socially responsible legislation. A good example of this is the cost of divesting from those involved in the genocide in Sudan. The UC Regents and State Pension Plan of California have done so as part of their divestment plan. On the other hand, it is more difficult to calculate the costs of the toxins routinely consumed as part of the normal diet. Even so, the richest families in the country have their children eating these foods. This has been documented in many studies, such as the recent study carried out on Mercer Island near Seattle, Washington [Schneider, 2008]. This community is the richest neighborhood in the highest per capita metropolitan area in the country. Still, the pesticides found in children’s saliva here are among the most toxic used inside and outside of the country. The study serves as an example that flies in the face of belief that consumers know what they are getting, and as proof of the negative results due to this ignorance.

*Opening the Economic Debate to Outsiders*

This paper proposes that this debate, in which we are supposed to choose between regulations to protect us or economic growth, is a fundamentally flawed debate; and that a deeper look has to be made to understand all the options available. There are many
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aspects of a society and its government’s policies that can be adjusted for better results in areas of concern such as the environment, economics and human rights. Just as we are complex, the way we analyze ourselves should be complex and consider all the relevant details. Such a discussion includes overturning established assumptions that we find are flawed by closer observation. Who is to say that society is always better off having, for example, a higher GDP? If we were to end up with plenty of expensive products and most of them were so toxic that they shortened our life spans, are we better off being poorer? GDP or any other economic indicator cannot truly represent our well being. Unfortunately, this paper will not be able to go into the depth necessary to reevaluate or evaluate all of economics and all the options for improving our system. We will focus on one aspect of economics: Adam Smith's assumptions of self-interested rationality and maximization in the market.

Milton Friedman’s arguments for less government intervention into the marketplace take us back to Smith’s view that the market naturally regulates itself. But, as mentioned before, this is a social science, and not a physical science, dealing with human psychology. Human psychology is complex as there are many reasons why people choose to do what they do. This is really the central issue in predicting the economic behavior leading to the study of economics in the first place. Smith’s assumption that people must make knowledgeable buying or selling decisions in order for his theory to work, begs the question, “Are people knowledgeable in these decisions?”

A New Debate Based on Knowledge

Knowledgeable? People are not even rational. Or to put it more diplomatically, it is part of the human condition that we are limited in knowledge and only sometimes rational. The answer can only be qualified as to degrees of knowledge, because people always have some knowledge but lack knowledge of most things, at the same time. So, this breaks down the argument that the law of supply and demand is some sort of absolute law, even though it should be obvious that no human law is absolute.

Hoping to give insight into how information is used and distributed in an unsymmetrical manner between consumers and producers. So, I carried a very simple survey. Whenever I went to go out to eat I asked, “What is the best thing you have, … and what is the worst?” Of course, I waited for the answer for the first part and then asked the second part. Every other time I asked for the best thing first and then asked for the worst thing as above. But, the other times I asked for the worst thing first. Out of twenty times total, everyone answered as to what the best thing was. One fourth of the total, or five times, they answered in some way to the question of what was worst, two times when I asked about worst first and three times when asked last. Fifteen times, or three-fourths of the time, they wouldn’t answer what is the worst thing they had. Of course, there is always something that one considers to be the best and always something that is considered to be the worst. For whatever reason information was given about the best and not so much about the worst, however subjective the information itself was. What was not subjective was the clear bias to give good information about a product and not give bad information about a product. The sad thing that comes to my mind is that we are used to this bias and people around me even found it rude for me to ask what the worst
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product was. The consumer is afraid to ask the producer the real questions about their product and expects little information. This is at the heart of the problem. So, what can we do?

**Outsiders Improving the System from the Inside**

As with Keynes’ approach, it seems more practical and more correct to build upon the strengths of Smith’s economic analysis, as well as those that followed, then to tear it all down from the base and start over. Besides, it is almost instinctually obvious that we can fix some economic problems by fixing the way that buyers and sellers exchange knowledge. Effectively, we can improve upon the application of economics by making its assumptions true, or truer. This is the information age, wherein the communication and analysis of information has so many new possibilities. There is so much opportunity to improve in this area. Milton Friedman might chime in at this point to warn of the danger of involving government, for reasons of corruption and inefficiency. At the same time Karl Marx would correctly distrust the usual entrepreneur and his government, as they are both for sale. Hopefully, Keynes would come up with the solution I will propose.

We need a different psychology. We need a psychology, political system and economic system of knowledge. What I mean by that is that we need to build a system that promotes people getting correct information. And to do that we have to recognize like Marx and Friedman, that those who typically will promote ignorance about products are most often the producers according to the former, and their cronies in the government, according to the latter. Who else is there? The consumer and the worker both have historically made out worse than businesses in our country, with exceptions, due to the dynamics of negotiations. It is no coincidence that the capitalist makes more money than the laborer, and it is much less of a coincidence that the average CEO of a company makes 500 times what the average worker with his company. Hence, enter the consumer union and the labor union. They have had their place and seemed to have filled a need to negotiate collectively and organize collectively. They have had some successes, but poor people can’t seem to get a break from the cycle of poverty, except those that escape to become skilled professionals or business leaders in their own right. On the other hand, as technology advances businesses have taken organization to a whole new level. Business is now global and has successfully organized along these lines, with accountability to the consumer or labor advancing slowly and often retreating.

It might seem like the workers and consumers of the world have been defeated; and at least temporarily, we are defeated every day. I beg you to find just one supermarket without the first pesticide ever outlawed, DDT, on any of its produce. Workers have many rights here, and consumers seem to have many rights. Everything works out fine, if workers in the United States are willing to buy goods manufactured by near slave labor, to make the kinds of ridiculous profits needed to pay CEOs what they make.
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Using the Matrix to Be the Solution

Fast forward to the present, and to the age of the internet. Now the same roads, of communication, used by the Romans to conquer and establish their empire can be used by those same people they conquered to take it back. The internet and the information superhighway are here and make the disparity between the rich and poor less significant in many areas. Many people can own a computer, even own a website, and have international recognition for that website. For the time being, the globe is one marketplace and is ruled by laws favoring businesses going global over consumer standard interests. But, as the world depends more and more on information technology, the playing field can be made more even. Consumer groups can organize on a global scale, do it more efficiently online, and use that same information technology to find out about the manufactured products they are exposed to. Only, once consumer groups unite along the lines of the internet, it will be much more difficult to break them down, and lie to them about the products in the market. An infrastructure with obvious benefits to society will have been constructed, that people in a relatively free society will resist giving up.

If eventually, as sometimes happens, these consumer groups gain the backing of the law, consumers will be even more protected. But, the most important change that could secure further change and protections for consumers and many other discounted groups is that of access to information. Anyone, given the chance, would most likely prefer a product that didn’t have some undisclosed toxin, and the free market would eliminate such common products. By the same token, many people would not accept products manufactured at the expense of the abuses we are only rarely informed of.

What are missing are not the social, political or economic conditions for such organizations to exist. What is missing is the catalyst or the activation energy to start that level of organization so that change happens spontaneously in our society. That catalyst is the insight that starting such an organization is needed, and the initiative to get it started. Building upon what this paper stated earlier, this organization would eventually be self-sustaining because of its usefulness and the need for independence from corrupting forces, such as investor stockholders or sell out politicians. We are basically talking about a non-profit organization whose source of income would not be subject to the approval of businesses or government.

Forming an organization like the one I am proposing is definitely problematic. A person might postulate that if such an organization doesn’t exist already there is a natural cause I am overlooking. There already are organizations like the one being proposed, but they fall short of fulfilling the role of the organization mentioned in degree. They are not widespread enough to be available to all. They only address a limited number of consumer issues. And, when they do address consumer issues they do not have specialized or relevant information. Most importantly, these organizations don’t provide information in a convenient or usable manner. For example, if you want to find information about a product in regards to allergens you have to go to one website for that allergen, which will not even give information about any particular product if it is available at all. After that, if you want to find out about the safety of a particular children’s toy you have to go to another website, where you may find relevant
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information about that toy, though you may not be even able to find the country of origin, or the manufacturer.

One or two websites bringing the others together are needed, that give product specific information. Because so much information is not made available to the public, this site needs to be interactive. This is so that the massive resource of individuals with knowledge about a particular product can contribute that knowledge for the public benefit. Hence, we are talking about a well known website, with organized links to specific areas of interest, product specific search engines and blogs in very specific areas of interest to bring a freer flow of information. I am working on this kind of website now. Care to help? Whether this will raise the Gross Domestic Product of a country or not, it is clear that better information will help us to not waste our money on poor quality products. If a consumer organization can make more correct information available when we need it, we can make the free market system work better for society and raise the standard of living wherever such organizations exist.

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MAKING A DIFFERENCE THROUGH E-GOVERNANCE FROM BELOW: AN EVALUATION AND FUTURE DIRECTIONS

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ABSTRACT

This paper discusses a process evaluation of a project funded by an Australian Research Council Linkage Project with the South Australian Department of Health, Flinders University, University of South Australia and Neporendi Forum Inc, an Aboriginal NGO. The co-researchers comprising academics across a range of disciplines, service users and providers address wellbeing in terms of their lived experiences of what works, why and how. The outcome is the development of prototype software that is co-owned by the partners and has been tested out by the participants. The process has taken knowledge management beyond storage and retrieval of information to include the perceptions and meanings of the stakeholders. It has potential to enable costing the pathways in social justice terms, in order to make a case for participation both as ‘a means and an end’ to support wellbeing within particular contexts. The software can be updated as it is used and it has the wider potential to be applied in a range of governance contexts. The use of meaningful metaphors designed by the participants could a) tailor the software to different user and provider groups by b) enabling the participants to collect data on their areas of concern.

User-centric design is based on telling narratives and exploring perceived ontologies or meanings. The next step is to analyze the discourses for patterns (Christakis and Bausch 2006 and Van Gigch 1991, 2003 on meta-modelling). Making sense of perceptions is through identification of patterns and making meaning/sense of the patterns based on weighting the choices. The number of times particular themes were raised or particular service choices made equals a weighting.

We used a pluralist approach and avoided a ‘one size fits all’ approach by using a) participatory action research and questioning, b) soft systems mapping, c) critique informed by Critical Systems Thinking and a Design of Inquiry System and d) social cybernetics applied to ‘if then’ scenarios.

The approach demonstrates the ability of people to design the content of the software and thus to engage in participatory design, e-governance and e-democracy which could be used to extend democracy to the marginalized and socially excluded. In the Australian context these include Aboriginal Australians, refugees and young people without the vote who will have to live with the decisions in the future. The current research is only with Aboriginal stakeholders aged 18 and above and it needs to be extended in the next phase to include younger Australians.

I will use most of the presentation time to give a practical demonstration of the software and to discuss its potential application.
1. **INTRODUCTION: WHAT IS THE PROJECT ABOUT?**

   This paper discusses research that is funded by an Australian Research Council Linkage Project with the South Australian Department of Health, Flinders University, University of South Australia and Neporendi Forum Inc, an Aboriginal NGO. We chose the most difficult problem in Australian context, namely social exclusion, unemployment, health, housing and addictions (gambling, alcohol and other drugs) with the hope that if we could create an interactive policy tool for a ‘complex wicked problem’ (with many interrelated variables and with a strong value base) (see Rittel et al 1973), we would be able to adapt the model to other less complex problems to inform policy on the basis of evidence.

   The purpose of this research is to explore the relationships with service users and providers in the public and private sectors, in order to enhance the policy performance match between agents and principals (Warren, 1999). Thus it a) explores the relationships across variables more deeply with service users, b) provides a better understanding of what works, why and how, c) informs policy decisions.

   Health, homelessness, poverty, alcohol misuse, gambling, family violence, unemployment, lack of skills and lack of social inclusion are the presenting problems that undermine Aboriginal wellbeing of service users. Service users are the designers of the research project on what ‘works, why and how’.

   The aim is to ensure that a) the service users build the capacity of the service providers, not the other way around to ensure a better match between perceived needs and service outcomes. b) to enable social inclusion (building on Carson et al 2007: 113, Bourdieu 1986 and a critical reading of Putnam 1995). c) connecting with others who are from the same background (bonding) and making connections with those who are different (bridging) and creating links horizontally and vertically to bring about change strategically. The value of matching is enmeshed in the process of engaging those who have lived experience in social life. Wellbeing cannot be achieved through compartmentalized thinking and practice (Fougere, 2007).

2. **RATIONALE FOR PRAXIS**

   The approach is based on complementary combinations of theory and methodologies matched to areas of concern defined by identifying all the stakeholders. In this context service users and service providers work with (rather than within interpretive, emancipatory approaches) by ‘testing out’ suitable matches with stakeholders who are to be affected by policy or practice. We test the hypothesis: The greater the use of participatory design processes to address complex problems (such as homelessness, family violence, drug use, unemployment and social inclusion issues) the better the problem solving outcomes for both human service users and providers. We test whether matching a response can alleviate the problem of an alienated and ill served community who vote, but feel that their diverse perceptions and needs are not addressed sufficiently by representative government and generic service delivery. It supports the recognition of diversity within the nation state and is open to explorations of the meaning of Aboriginality for wellbeing and identity. The process of engagement is in itself important for democracy, personal and public accountability for wellbeing and for advancing scientific research by extending the testing process. The mapping process is designed for supporting sustainable design for social and environmental justice for this generation and the next, not merely to predict or control for narrow sectarian interests. The process draws on the wisdom and tacit knowledge of people who are at the receiving end of policy and ensuring that they have a say in shaping the direction for the future and matching their needs with services
and resources with this generation of life and the next in mind. This conclusion is the starting point for this research into public ethics in a global context where national boundaries need to be reconsidered to take into account regional and global sustainability.

3. DESIGNING THE ARCHITECTURE OF THE KNOWLEDGE BASE TO AID UNDERSTANDING BY BOTH SERVICE USERS AND PROVIDERS

As detailed in McIntyre-Mills 2007, 2008, forthcoming) the research process involved:

- Design of the content of the software through conversations, soft system mapping and weighting the number of times certain factors are closely related to each other.
- Using informatics to map pathways based on a generic computing algorithm.

Stories from co-researchers (both service users and providers) reveal domains of wellbeing described in terms of a continuum of overlapping domains with components made up of variables that need to be considered. The following dimensions of wellbeing:

Table 1:

<table>
<thead>
<tr>
<th>Dimensions of wellbeing</th>
<th>Indicators</th>
</tr>
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<tbody>
<tr>
<td>Physical health</td>
<td>Safe housing (free of violence) in a safe community, regular meals, household goods to support wellbeing (stove, fridge and washing machine, furniture), clothing, dental health and physical health.</td>
</tr>
<tr>
<td>Mental health</td>
<td>Good interpersonal skills, a sense of respect and belonging, trust in a network of people</td>
</tr>
<tr>
<td>Socio-cultural</td>
<td>Routine roles to maintain a household and connections with a community Access services such as health and education</td>
</tr>
<tr>
<td>Political</td>
<td>Engaged in decision making outside the private sphere, Sense of rights and responsibilities</td>
</tr>
<tr>
<td>Economic</td>
<td>Access to employment and Learning literacy, numeracy and computer skills and confidence.</td>
</tr>
<tr>
<td>Environmental and spiritual</td>
<td>Connections with ‘country’</td>
</tr>
</tbody>
</table>

The words of the informants were used to summarise each theme. Typologies represent typical (but not fixed) overlapping domains. Changes from one domain to another were summarised as 6 dimensions (in
baskets, out baskets, barriers, turning points and services that worked for them). As detailed elsewhere (McIntyre-Mills 2007c, 2008 forthcoming), the entry point for the user is as follows:

- **Step one**, please tell narrative. Then see which of the stories (based on the typologies) is closest to your own story. Select a story and explore and discuss with the service provider which story resonates and why.
- **Add more information** as data to enrich the knowledge base and to help the next service user.
- **Walk through** the interconnected and overlapping pathways and collect items for basket (based on the drawings and stories) and select items to discard (based on the drawings and stories).
- **Identify the barriers** on the pathway and give them a name.

Based on an analysis of the data, wellbeing for service users can be understood as a state that can be interpreted in many ways, it has many domains. For some it is:

1. ‘**Being employed**’ and ‘able to help others’, because their ‘life is in harmony’;
2. ‘**Rebuilding**’;
3. ‘**Making a transition**’ by using a combination of services¹;
4. ‘**Keeping it together**’ after leaving a violent situation and trying to control drug and alcohol misuse – use cigarettes extensively;
5. ‘**Making the break**’ from an unsatisfactory way of life;
6. ‘**Not coping**’ and unable to leave or repeatedly returning to a violent situation.

Instead of using a flat continuum from 1-6, we modelled a series of overlapping spirals spanning holistic, integrated service delivery to fragmented and compartmentalised delivery of services as options with many variants in between (See Downes 2006: 36). Those who are most in need require the most integrated services and the most participation in decision making. Those who are least in need require the least integrated services and are able to draw together services for themselves and act as facilitators for others, volunteers in service delivery or act as service providers for others. The challenge is to map the turning points for the a) better or b) worse that lead to changes in life and to c) identify the barriers from the point of view of both service providers and users. The metaphor of baskets is based on the women’s metaphor of ‘weaving together strands of meaning’ (McIntyre-Mills 2006, 2007).

¹ Using CDEP, ASK job network, Neporendi and Cultural ties.
These patterns are drawn from analysing the stories of women and men. The overarching architecture for the knowledge base in this model as illustrated below:

Figure 2: Sequence Diagram of System, De Vries 2006 (WIP), 2008.

The description of the prototype by De Vries appears in McIntyre Mills, 2008 forthcoming, Part 1. Part 2 on the architecture by De Vries operationalises the prototype.
4. MEANING MAKING

Wellbeing is a complex and contextual outcome that must reflect individual variance. The approach is critical, links theory and practice is contextual and systemic. We conclude that bureaucratic and compartmentalized responses are inadequate to address complex multifaceted problems. The paradigm shift from the machine metaphor associated with lineal thinking to the complexity metaphor of interrelated systems and networks shape the research. People who experience the policy outcomes in their everyday lives need to fine-tune the policy through social inclusion in the design and monitoring of what works, why and how which has implications for representation and accountability. Open communication is mindful of multiple viewpoints, meanings associated with different cultural maps. It addresses ways to enhance knowledge management and decision making so as to narrow the gap between service users and providers. More profoundly, it enables the complexity of policy decisions to be matched by the complexity of the decision makers. Also to build in the rational testing process so that personal decisions are based on ‘if then’ scenarios, so the narrow pragmatist or ill informed decision maker is prompted to think through actions to enable decisions based on expanded pragmatism that sweeps in social, economic and environmental considerations for now and the future. Short run gains could be understood to boomerang as losses (poverty and pollution) that impact on their own safety or that of their children (Beck 1992, 1998, McIntyre-Mills et al 2006c). It needs to be supported by case workers for people in clinical situations, but it can be used creatively to enable moving beyond integrated decision making (Bammer 2005) to enable critical and systemic thinking, design and practice in a range of contexts in the public and the private sector.

As stressed in McIntyre-Mills (2007a, b, c, 2008), the theory of sociocybernetics (Beer 1974) stresses that understanding non-linear relationships is a first step to developing policy responses. The data show multiple non-linear relationships across:

- Socio-economic disadvantage that cause discrimination in housing options and prevents access to a home.
- The lack of security provided by a home base equipped with electricity, white goods and essential furniture from which to get a job, training or education.
- A sense of connection with a supportive wider community supports stable relationships. A home, sense of place is a necessary, but insufficient dimension of wellbeing.
- Domestic violence results in a lack of confidence and a sense of hopelessness.
- Hopelessness and a lack of confidence (as a result of their prior experiences) lead to women accepting domestic violence, because they do not know how to escape from it.

Context is all important to the design as the perceptions expressed are based on specific experiences which will be developed into conditional scenarios to guide action.

3 The systemic approaches to the management of complex problems build on the work of critical systems thinking and practice (Jackson, 2000; McIntyre, 2000, 2002a, b, c, 2003, 2004; Romm, 2001, a, b, 2002; Flood and Romm, 1996; Midgley, 2000; Churchman, 1979, 1982 and Zhu, 2000).

4 These suggestions are however, only meant to guide decisions made by service users together with a service provider, who could sit side by side and use the computer program to help identify which narratives resonate with their own experiences and explore the choices made by others and then to consider their own possible responses that could be added to the program. As each service user works with the program they will add items that they perceive to be valuable for the ‘in baskets’, items that need to be discarded. They will identify the turning points they have experienced for the better and the worse and the barriers (De Crespigny et al 2002) they have experienced.
The computer program learns as different users contribute and this is achieved by positioning the factors (that the service users perceive to be important) as synonyms in response to contextual scenarios by case workers in the domains section of the software. We need to continue to test the program to establish if it enables greater self knowledge and learning from others and better decisions, based on pattern recognition that could also help to make sense of the trauma and losses they have experienced.

We have concluded, however, that participating in an active, constructive way in designing alternatives appears to be important as ‘a means and an end’ to support wellbeing. Being ‘shamed’ by service providers was discussed as being one of the greatest barriers (on this also see Atkinson, 2002) to healing as it creates a sense of victim hood and leads to mistrust. If the dynamics make you feel disrespected, it undermines opportunities to build connections and pathways to wellbeing. The emotions felt by those who are turned away from service providers were expressed graphically as unfriendly interactions with intimidating, unsmiling service providers. What works, namely a circle of women talking as equals. This is supported by the work of Ainsworth and Bowlby (1991), Brewer and Hewstone (2004), Atkinson (2002) as well as Greenfield (2000) all of whom stress the importance of engagement that builds linkages across diverse groups, based on trust. Unfortunately negative racist, sexist communications have an opposite affect which is why supportive networks are vital for wellbeing.

The data from two men's focus groups and from two combined focus groups with men and women service users stress the importance of not only respectful communication and interactions, but warmth and friendliness. Borradori, Habermas and Derrida (2003) take up this issue and stress the implications of the quality of communication for democracy. Respect is not enough, warmth and the quality of the engagement matters. This requires building rapport through “two-way communication”. Gore (2007) argues that one way communication raises many problems for democracy and the way in which two-way communication is vital for building relationships and creating attachments between people at the individual level and also at the societal level.

“As Miller and Ferroggiaro (1996) have pointed out ‘respect and self respect are central components of an enlarged concept of citizenship…Respect affects how we are treated , what help from others is likely, what economic arrangements others are willing to engage in ..., when reciprocity is to be expected’. Respect acts as a resource for individuals, and should be considered a component of the norms of reciprocity, trust, and social obligation that are essential for minimising the risks of poor physical, psychological, or social health (Aday1994). Indeed, mutual respect and the avoidance of inflicting humiliation on people is the central concept of Margalit’s ‘decent society’ (Margalit 1996). …honour and shame are soc crucial to human relations and may often become issues of life and death has long been recognised....” (Wilkinson 1998: 594).

Democracy is currently increasingly criticized for not representing the interests of diverse citizens and for not taking into account the social justice and environmental concerns that span national boundaries (Beer 1974, 1994), Habermas, Derrida, and Borradori, 2003, Pape 2005, Devji 2005, Singer 2002 and McIntyre-Mills 2003, 2006a,b,c). As Savage (2005: 330) argues, there are many kinds of bureaucracy and current democratic forms are in need of an overhaul. Revitalizing democracy (Putnam 1995) and democratic institutions by finding new ways to engage the marginalized is the challenge (highlighted by Savage 2005) to which this research is addressed. Florini (2003: 83) sums up the challenge as follows: “…when decision making reaches the rarefied level of intergovernmental organizations or even informal multilateral rule making, the threads of democratic accountability can be stretched very thin. It is often hard to see such decision making systems as a means by which the people of the world, through the instrument of their freely chosen governments, resolve their common problems. … Accountability to the general public is at best indirect, and often, for all intents and purposes, it does not exist at all …[The] mechanisms we have put in place to deal with large scale collective action problems seem so thoroughly inadequate when matched up against the scale of the problems…”.

The data from service users has produced very specific recommendations about a) meeting safety concerns that go beyond just physical housing and b) the importance of social networks to support those who have complex needs. c) Throughout the very detailed stories, supported by pictures and vignettes, the informants have stressed the value of respectful interactions from service providers.

The ‘in basket metaphor’ refers to the aspects that people perceive they need to enhance wellbeing. The ‘out basket’ metaphor refers to aspects they need to discard to enhance wellbeing. ‘Barriers’ refer to aspects that prevent wellbeing and turning points refer to positive and negative events. The data organised within the proformas highlighted the themes and the relationships between them (Figure 3).

Figure 3. Graphical structure of issues and their inter-relationships (De Vries in McIntyre-Mills et al 2006: 295)
3.1 Interactive modeling process

Once a preliminary analysis of the confidential, de-identified data was undertaken a series of iterative workshops were held to explore the map of factors with the participants to find the shortest pathway approach to achieving wellbeing outcomes. But the pathways are based on the perceived lived experiences of the service users as to what constitutes successful, integrated outcomes. The interactive modeling process could support matching services to need as long as it is seen as an aid to decision making and an aid to e-governance- not as a means to predict and control. It could also be used to enable accountability by making the pathways of choices transparent to users and providers.

The narratives and pictures (both abstract and concrete representations) were used to develop metaphors of weaving together strands of experience into baskets that could be used to:

- Tell their unique personal history shaped by a range of social, economic and environmental circumstances.
- Explore how it has been shaped by their experiences, for example of violence at home, homelessness, or unsafe neighbourhoods and limited networks.
- Identify with a story that others have told and explain how it is different and similar
- Assess positive life lessons and identify assets that they have and need for their ‘in baskets’.
- Discard the problem areas from their lives by taking personal responsibility and
- Seek assistance to address identified needs that have been prioritized through considering their specific circumstances.

The model of the process is for the service user to tell their story to a case worker who listens and who builds rapport over time and then to choose which of 3 basic stories is closest to their own. They then adapt that story in detail to their own by adding factors to the map. Thus it grows to accommodate their needs. The most positive aspects were considered to be its potential for creativity, innovation and social inclusion. Mapping ideas conceptually is important for making sense of one’s life. This is important because of Miller’s conjecture (1956) that human beings cannot hold more than a few variables in mind at a time, they cannot make all the connections across them. Dynamic models can help to make sense of the issues which they face.

These patterns are drawn from analysing the stories of women and men. Wellbeing can be seen as having the following dimensions, as detailed in Figure 4:
Combinations of 5 axial factors appear important at this stage of the analysis:

- **Home safety** (and being free of violence)
- **Health** (physical and mental health – appearance, energy)
- **Purpose** (Formal Employment or preparation for employment /profession employment/CDEP / training / education)
- **Connection/belonging** (people and place), volunteering, community leadership and cultural spirituality
- **Self respect and confidence**, feeling good about oneself which is linked with being able to access services, work, study, maintain a stable home for children.

The inference from the analysis of the data so far is that by providing a combination of factors (safe housing, meeting basic physical needs then accessing education and employment) wellbeing becomes possible. To overcome barriers in accessing services, it is vital that service providers in mainstream and specific services are welcoming to ensure that the confidence of service users is built. The role played by holistic or (one–stop shop outreach) is important in this context as it enables rapport and relationships to be formed. Also a quickly
negotiated pathway capable of dealing with 5-7 variables to ensure that the above mentioned axial themes are addressed effectively and efficiently would enable better outcomes.

5. **AN EVALUATION OF SOFTWARE**

An evaluation of software designed in partnership with an Aboriginal NGO and the South Australian Department of Health and the Australian Research Council was held on the 12 February, 2008 at Flinders University entitled “User-centric Design: Pathways to Wellbeing”. This was a timely date, just prior to the apology made by Prime Minister Rudd for the past injustices to Aboriginal people. The workshop was attended by Aboriginal and non Aboriginal health service providers and academics. Wellbeing is a perception of quality of life that spans a number of interrelated factors, but it is underpinned by meeting not only basic needs but by being involved in one’s community and having a sense that one is able to influence one’s social environment. The viewpoints of service users /members of the public form an integral part of policy making to achieve a perceived sense of wellbeing.

The most negative aspects were based in part on the fact that the prototype needs a touch screen interface to enable a range of users to traverse flexibly through the data. The most positive aspects were considered to be its potential for creativity, innovation and social inclusion. The most negative aspects were based in part on the fact that the system is still a less than robust prototype without the Java interactive interface needed to be able to traverse more flexibly through the data.

Other comments reflected a lack of understanding of the design as they were concerned about the need to have more complex stories as a starting point for the software, without understanding that the complexity begins with the service user’s story which is used to update the existing software. Overall the feedback was positive and the next step is to find a way to find finding to take the generic prototype to the next stage and to find ways to generalise the software to other areas such as service delivery to local government or matching the needs of diverse interests within regional areas. This would involve working across national boundaries that are both conceptual and spatial (including organisational). This is a big step and needs the support of interested groups to assist us with the process of approaching both public and selected private sector funders.

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7 The project grew out of institutional design in capacity building to enable better communication across conceptual and spatial boundaries. The process of engaging stakeholders was all important to addressing wellbeing which is a complex, interrelated concept based on perceptions and values along with the meeting of core basic needs, it requires respect and a sense of being connected with the community in which one lives. The approach is dedicated to extending participatory democracy and governance to Aboriginal service users, based on their perceptions of what works, why and how, but it has greater potential for more generic application.

8 The process is for the service user to tell their story and then to choose which of 3 basic stories is closest to their own. They then adapt that story in detail to their own by adding factors to the map. Thus it grows to accommodate their needs. The distinctions across some of the factors such as have and needs is arbitrary, because it is based on their perceptions, not on different lists.
<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The program has a memory. Helps with access to services and awareness of services available. Computer access for clients. Helps with self awareness and a chance for people to take control of their own lives. Useful and easy to use. A nice way to identify needs. Innovative ideas /tools to match needs. Good design and a clear bright screen. Great way of thinking through and documenting stories experiences and plans. Good start in helping people think about their situation and options. Having a print out to keep with them would be useful. It provides a structure for helping people that can be constantly built upon. Will make it easier to see whether clients are making progress. Provides options for easier access to useful information rather than ploughing through copious case notes. Makes providers think about client’s real situations as well as making clients think about this. Private information if desired by not using one’s own name. Can print out ‘where you are at’ and ‘where you want to go’. Interesting use of technology. Good use of narrative and personal stories which validates the qualitative approach. Like the aspect of relating to</td>
<td>Timeline for the actions is needed Need to distinguish between violence within a household and extended family violence. Concentrated activity may be too intense for clients and they may need to have a day to go through the programme and the whole pathway may be too much to consider at any one time.</td>
<td>Friendly facilitators are needed to work with people to promote the program at places like Centrelink and women’s centres. Envisage the program to be used in waiting rooms of Sexual health clinics and by counsellors. Best way to understand the program is ‘to have a go’. Service providers need to know about the program. It needs to be promoted. This needs to be tested out for each user group and modified with a facilitator. The steps in the pathway could be presented as a route that could take many months or years to achieve. Monitoring of use and outcomes needs to be ongoing. ‘Web based’ library or sharing of local and regional information with Community services and commonwealth Possible interface with CISA data base of community services. The concept/tool could easily be modified to any environment where there is a partnership between workers and clients in health services such as Torrens House working with staff on parenting. Service users need to work</td>
<td>The language in the stories and in the drop down menus needs to be customised for the user groups so that the worker is not more powerful than the service user.</td>
</tr>
</tbody>
</table>
along side case workers who can help them to identify personal barriers.

Opportunity to share resources/knowledge between people or for data to be de identified so pathways not people are the focus.

Need to list grief, fear, loss, pain, sadness, and suffering.

Fairly easy to use. It will develop into a useful tool that captures clients and workers knowledge.

### Table 2: SWOT of Software design to date (McIntyre-Mills 2008 forthcoming)

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Opportunities</th>
<th>Weaknesses</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good use of a positive proactive approach. Tool to focus on needs and actions that are realistic. Concept of baskets (in and out) is good and concept of turning points is good.</td>
<td>Opportunity to share resources/knowledge between people or for data to be de identified so pathways not people are the focus.</td>
<td>Need to list grief, fear, loss, pain, sadness, and suffering.</td>
<td>The program is user-friendly.</td>
</tr>
</tbody>
</table>

Some of the service **providers** who tested out the program did not understand that user perceptions shape the pathways and the users decide what they are going to put into their ‘in and out baskets’. The service users decide what **they** think is positive and negative. The ‘if then scenarios’ are about testing out ‘what if I were to do the following’ and then seeing the implications of decision in the pathway. This testing out of ideas is the basis for learning. The complexity begins with the service user’s story that is used to update the existing software. The program enables both the service users and providers to add information so that richness of the pathways can be increased. In other words, the program learns and grows. The idea is not to provide the user with many complex stories, just a starting point for the user to tell their **own unique** story, reflect on it with the case worker and then to build their own detailed story into the spaces provided. The stories of other people are only portals for entering their own unique details.
6. OUTCOMES

The intended outcomes were as follows:
1. More effective matches of services to perceived need.
2. Better able to combine services to meet complex needs. This has implications for governance, because people at the receiving end of the decision can test out ideas and so this makes the rhetoric of subsidiarity a reality, namely good for democracy and for science. It provides a generic tool for governance and has implications for e-governance. Pattern recognition and meaning making is vital for making sense the trauma and losses they have experienced.
3. Taking an active, constructive step away from the problem towards co-creating a solution, because the service users become participants in designing solutions and they take control of their healing.
4. Capacity building of service providers by service users.
5. Improved outcomes for service users.
6. Develop and pilot a computer tool to inform decision making by both users and providers.
7. Creation of an updated data set on the areas of concern.

The first three outcomes have been achieved but outcomes 4-7 will be an ongoing challenge for the future. The involvement of the participants extends democracy and governance and enables network governance to occur.

7. FUTURE DIRECTIONS

Fragmented thinking has implications for policy and practice. It excludes and alienates and is inherently respectful only of power. A personal and public morality and conscience is supported by ethical thinking in terms of apriori norms and aposteriori consequences of our actions for self, others and the environment. Balancing individual needs and group norms requires reflection and deciding on where to draw the boundary of what is acceptable and what is beyond the pale (Midgley 2000)⁹.

⁹ According to Scheff and Retzinger: “adaptive problem solving requires part/whole analysis, understanding the relations between parts and wholes. This is largely a cognitive capacity, although emotions also play a part. Moral behaviour requires understanding the
Wellbeing is a perception of quality of life that spans a number of interrelated factors, but it is underpinned by meeting not only basic needs but by being involved in one’s community and having a sense that one is able to influence one’s social environment (McIntyre-Mills, 2006c, 2007a, b, c). The viewpoints of service users/members of the public form an integral part of policy making to achieve a perceived sense of wellbeing (McIntyre-Mills et al 2006c).

8. CONCLUSION

We have demonstrated that the process works very effectively for a complex problem which requires a holistic and simultaneous intervention. It has strong applicability to other areas such as enabling young Australians to have a say in reducing the size of our carbon footprint at the local government level. The social, economic and environmental factors to support wellbeing could be used as a basis for their deciding on what needs to be added to their ‘in baskets’, ‘out baskets’, what the ‘turning points’ will be for the better and the worse. They could consider what we have now and what we need for future generations and use tests for sustainability (Murray et al 2007). The implications are that the voting process could enable people to engage in discursive democracy and to shape decisions of policy makers who will be able to count the number of times people have made particular combinations of selections.

But also – more importantly – the ‘if then’ scenarios could enable them to think through the implications of choosing one pathway rather than another, so it will help to build social responsibility and a sense of rights. The process of engaging stakeholders was all important to addressing wellbeing which is a complex, interrelated concept based on perceptions and values along with the meeting of core basic needs.

Wellbeing requires respect and a sense of being connected with the community in which one lives. The design of inquiring systems approach (West Churchman, 1971, 1980) is dedicated to extending Critical Systems Thinking (see Jackson 2000, Flood and Romm 1996, Midgley 200, 2007, to participatory democracy and governance McIntyre-Mills 2003, 2004, 2005,2006a,b,c) and specifically to Aboriginal service users, based on their perceptions of what works, why and how. We conclude that people who experience the policy outcomes in their everyday lives need to fine-tune the policy through social inclusion in the design and monitoring of what works, why and how which has implications for representation, accountability, accounting and risk consequences of one’s actions, of the part they may play in the whole system of relationships in which one is involved. Although part/whole analysis can be undertaken intentionally, slowly and systematically, as in careful linguistic work on the structure and meaning of dialogue, and in the ethnography of cultural artifacts, it is usually involuntary, rapid and covert... The emotions most central to conscience are probably pride and shame. Lewis refers to these emotions as the ‘moral emotions’ (1976). Normal shaming is conscience building. The caretakers approval results in pride; disapproval in shame...a secure bond involves what Stern calls attunement: the parent and child are intellectually and emotionally connected in a way such that each ratifies and legitimates the others existence...the ratification of oneself, of both being and doing, seems an instinctive feature of all humans and other social creatures...” (Scheff and Retzinger 2001: 177-179). They go on to make the case that human beings who fragment their thinking can become immoral. “Specialisation has its uses, but a general problem-solving ability - that is basic human intelligence – requires... playful, spontaneous kind of thinking and feeling...” (182). Linear fragmentation of thinking and practice can be a convenience a rationalization for not taking acknowledging rights and responsibilities, for not balancing individualism and collectivism. The project grows out of institutional design in capacity building to enable better communication across conceptual and spatial boundaries.
management. It is rational to extend the testing process beyond professionals and to draw on the lived experiences of people who can provide valuable insights on the issue.

The point that needs to be stressed is that representation and accountability rest upon testing out and matching responses to context. This requires an expanded form of testing so that those on the receiving end of the decision are part of the testing process. This upholds both the principle of subsidiarity and Ashby’s Rule (1956) which was tested out in this project. The research has potential for more generic application.

Enhancing representation, accountability and social inclusion will be on the policy agenda for the foreseeable future. Future research needs to focus on ways to enhance policy making by testing out young participant’s ideas based on questioning and considering options. Thus it could develop a new intergenerational approach based on understanding views from below, in order to explore areas of convergence and divergence in the area of representation and accountability (Christakis and Bausch 2006, McIntyre-Mills 2006b, c 2007c). ‘User-centric design for wellbeing’ to enhance policy making is a new area of research to enhance accountability (McIntyre-Mills 2007a, b, 2008 forthcoming). It connects the diverse theories on the need for better representation, intergenerational social, economic and environmental accountability and sense making (across the sciences) to support wellbeing with diverse, young stakeholders. It will fill a gap in the understanding of the relationships across energy futures, climate change (Flannery, 2005, Stern, 2007, Odum 1996) and identity formation by integrating the following bodies of literature through a critical systemic research and analysis:

- Intergenerational accountability

10 The process used in the project was to move from the complexity of personal stories to typologies based on their perceptions then to ask them to select one of the typologies which will be a starting point for building their personal story.

11 How do we achieve governance, accountability and greater capability in a post wealth society where sustainability based on systemic rather than single line accounting? In ‘Environmental Accounting’ Howard Odum, a systems thinker explains that accountability for wellbeing is based on assessing ways to live sustainably with the next generation of life in mind. He reminds us that all wealth is “produced from and maintained by the environment, sometimes helped by people and sometimes not…” (Odum 1996: 6). Thus to achieve the United Nation’s Millennium Goals for a sustainable future requires rethinkig accountability and accounting processes, because climate change (affected by odin emissions) impacts on all aspects of life and is critical for our wellbeing. The work of Howard Odum on ‘environmental accounting supports the rationale for the research. Elkington supports triple bottom line accounting, starting point for a new score card. Pierre (2000) and Florini (2003) discuss the importance of participation to enhance accountability. Florini stresses that the Aarhus convention could inform the process of governance. McIntyre-Mills (2006c) in Systemic Governance draws on Christakis with Bausch (2006) and Singer (2000) to argue for the value of subsidiarity and the importance of contextual matching. These elements together with the informatics software developed in the research could make a difference. The challenge for both representation and accountability is to enable us to balance individualism and collectivism. Extreme forms of individualism lead to the undermining of the ‘greater good’ and public interests, because of egotism and the pursuit of personal interests. A case in point is the way in which American electoral process spends vast amounts of money on individual candidates within both major opposition parties. The extreme forms of collectivism lead to the undermining of individual rights and responsibilities and the control of the state. Both extremes pose casualties for social and environmental sustainability which rest on matching balanced responses to specific areas of concern, but which are still governed by the principle that we can be free to the extent that we do not undermine the diversity of others within this generation and the next. This requires a delicate balance of apriori norms and aposteriori performance measures. This requires ensuring that the matching process takes into account the test of whether the decision is in the interests of both this generation and the next. Accountability cannot extract from the next generation to support a current generation’s life style. The mistake made by Darwin in his discussion about the survival of the species acco to the social psychologist Triandis (1995:5) is that we need to consider competition not of individuals but of the collective species within their environment. Cultural lenses of individualism helped to shape his theory, which is why we need to be mindful of theories and be open to testing out ideas.
2003, Elliot and Lemert 2006) with perceived wellbeing and the concerns of those who struggle to be heard and are most likely to be disadvantaged in an increasingly networked world (Castells 1996, 1998) unless processes enable user-centric design (Banathy, 2000, Christakis with Bausch, 2006, McIntyre-Mills 2003, 2006).

8.1. Addressing the wicked problem of social justice and sustainability through enhancing participation

Addressing complex wicked problems of climate change, epidemics, security and pollution remain central problems for democracy and governance internationally (See Held, 2005). This research explores the extent to which participation as a means and an end enhances the capability of people to make rational choices for themselves and others through thinking through options. The global commons is under threat (Held, 2005, Stern 2007) and we need to find a way to address the challenges in such a way that we can address sustainable futures whilst balancing collectivism and individualism.

8.2. How people speak to the future on sustainable energy and wellbeing

We need to:

- Gather data based on young people’s perceptions and experiences of positive ways to reduce our carbon footprint to support wellbeing, through community based activities and life style changes.
- Ensure that those who will have to live with the decisions have a say and are not excluded from networked society.
- Collect the data using a multimethod approach comprising research conversations, arts and narrative to inform the development of software for integrated decision making based on their own experiences and world views (see McIntyre-Mills 2007).
- Enhance decision making by enabling the participation of diverse young people so that they can have a say in policy making and ‘debating governance’ (Pierre 2000) to address their social and environmental concerns (McIntyre 2006 a, b, McIntyre-Mills 2000, 2002 a, b, c, 2003, 2006c, 2007a, b). Bourdieu (1977) in the ‘Outline of a Theory of Practice’ stresses the importance of understanding the worldview of participants. He talks about the landscape of ideas and concepts which people inhabit. Representation and accountability for a sustainable future is assisted by matching domains of knowledge to areas of perceived concern by testing out ideas with those who are to be at the receiving end of the decisions and with future generations in mind (McIntyre-Mills 2007d).
- Work with local governments and schools to facilitate the action research with young people based on our prior wellbeing, quality of life and development related projects. These local government areas include culturally diverse young people with diverse life changes. The processes and the empirical data could be used in the public and private sector. The strength of the research is that it could focus on a shared area of concern, namely: social and environmental sustainability challenges.
By developing a ‘design of inquiry system’ (see Churchman, 1971, 1982) to broaden the participation of the marginalised and young people so that they can have a say in policy making that meets their social and environmental concerns.

The options and practical implications for democracy and governance policy and include: Isolationist, nationalist realist stances based on the notion of separate interests and separate world views will lead to competition and conflict. Multilateralism based on diverse pluralist ideas based on communication across conceptual and spatial boundaries is vital, but requires the capability to think critically and analytically and to engage in dialogue. Multilateralism based on federalist regions spanning national boundaries based on commensurable shared commons, informed by subsidiarity and the notion of Ashby’s Rule of Requisite Variety and an understanding of our common fate as ‘one world’ could provide a way forward. This requires the capability to think through ‘if-then’ scenarios so as to develop an understanding of shared concerns about rationality and the extent to which democracy is failing (see Christakis and Bausch 2006, McIntyre-Mills et al 2006, 2008 forthcoming).

REFERENCES


12 This could enable us to test ways to ensure that those who are to be at the receiving end of a decision are part of the decision making process, so that the complexity of the decision is matched by the complexity of the decision makers. Better processes to ensure social inclusion and participatory democracy could address wellbeing more effectively. These issues of accounting and accountability have been raised by Indigenous thinkers internationally.
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A BASIC PRINCIPLE FOR THE ARCHITECTURE OF COMPUTER-BASED INFORMATION PROCESSING

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Abstract

In this paper we discuss the effect of computer-based information processing on the adaptability of the systems. Because of the close relationship that exists between subsystem independence and adaptability, the effect that the structure of computer-based information processing has on the degree of independence between the subsystems of the system that makes use of computer-based information processing (referred to here also as the host system) is central to our discussion. We are focusing here on complex systems that are controlled and operated by humans with the help of computer-based information systems and that face an uncertain environment. This type of systems includes organizations, complex projects, and complex processes and devices controlled by humans with the help of computers. The view of information processing as an aspect of the dynamics of systems (Kampfner, 1998) is also central to our discussion. An important advantage of this view is that it allows us to study the relationship of information processing with other aspects of the dynamics in which it occurs. This in turn gives us the potential to understand the role that information processing plays in practically any particular kind of natural and artificial systems.

Three closely related, but distinct types of interdependence between the subsystems of a system can be distinguished. The first one is the interdependence between the computer-based information system, itself a subsystem of the system it supports (referred to here as the main system) and the other subsystems of the main system. The second type of interdependence is the one that exists among the other subsystems of the main system. The third type of interdependence is between the components of the computer-based information system. These three types of interdependence between the subsystems of a system are clearly closely interrelated. Each of these types of interdependence has characteristics that distinguish it from the other types. The first type of interdependence is characterized by the combination and the interaction of human and computer-based information processing.

At the core of these three types of interdependence is the role that computer-based information processing plays as an integral part of the processes that perform the functions of the host system. An important part of this role is to undertake part of the information processing aspect of these processes. In doing so, a computer-based information system becomes an integral part of the processes that it supports with information. The interdependence between the computer-based information system and the subsystems of the host system that it supports (the first type of interdependence)
The Architecture of Computer-based Information Processing

systems from its role as a provider of information to the subsystems it supports with information. It is therefore inherent to the role that computer-based information processing plays in the processes that perform the functions that the subsystems involved represent.

Computer-based information processing affects the second type of interdependence in an indirect manner. Any change in the information processing aspect of the dynamics of a system has some effect on its structure and dynamics. Since the introduction of a computer-based information system changes the structure and dynamics of information processing in the host system and this ultimately results in a change in its overall structure and dynamics, it is obvious that it also affects the interdependence between the subsystems. A new, or modified, computer-based information system can reduce the second type of interdependence by taking up some of the informational interdependencies that the subsystems its supports have between them. The reason is that by exchanging with the subsystems it supports information that otherwise would be exchanged directly between these subsystems makes them less dependent on each other. However, it should be noticed that, for the same reason, every reduction of the interdependence between the subsystems that the computer-based information system supports results in an increase of the interdependence between these subsystems and the computer-based information system.

The third type of interdependence occurs between the processes that the computer-based information system provides. The structure of computer-based information processing affects this type of interdependence because it entails a particular set of relationships between the components of the computer-based system such as the pattern of distribution of computer-based information processing, the type of interaction that exists between the components of the computer-based system, and other types of interdependences between components that the structure of the computer-based system imposes. The structure of computer-based information-processing also affects the other two types of interdependence. It does so because it participates in the influence that the overall structure of the host system has on all the aspects of the dynamics of such a host system. The structure of computer-based information processing contributes to the overall influence that the structure of the host system has on the overall dynamics through the influence it has on its own dynamics (i.e. the way in which the computer processes proceed), on the dynamics of human information processing (i.e. the way in which humans process information in the host system), and on all the other aspects of dynamics of the host system including those that do not deal with information processing.

Our emphasis on the effect of the architecture of computer-based information processing on the adaptability of systems responds to the fact that the structure of any system influences its dynamics and its adaptability. Just as information processing is an integral part of the dynamics in which it participates, the architecture of computer-based information processing is an integral part of the structure of the host system. As such it partakes in the influence that the structure of the host system has in its own dynamics including the information processing aspect of this dynamics. As part of the structure of
the host system, the architecture of computer-based information processing influences the dynamics and adaptability of the host system and, consequently, its own dynamics and adaptability. Focusing on the architecture of computer-based information processing thus helps us investigate its contribution to both, the dynamics and adaptability of computer-based information processing itself, and the dynamics and adaptability of the host system. These two types of contribution of computer-based information processing to adaptability are closely interrelated and involve tradeoffs that, as explained below, the designers of computer-based information systems must handle properly if these systems are to contribute effectively to the adaptability of their host systems.

Clearly, an important goal of the designers of effective computer-based systems is to design an architecture of computer-based information processing that enhances the power of human information processing while preserving or enhancing the ability of the host system to cope with the uncertainty of its environment. Some relevant features of this architecture and its relationship to subsystem independence and adaptability are discussed in this paper.

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LUDWIG VON BERTALANFFY’S EARLY SYSTEM APPROACH

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ABSTRACT
Most of what Bertalanffy published in the field of “organismic” biology was written in German and is thus not widely known. In order to understand the development and meaning of his “general system theory” – which might more accurately be called “general systemology” – those early works are essential. In this talk I will therefore focus on key aspects of his “system theory” of life, both on the level of scientific concepts and philosophical considerations. This will also include a note on works that influenced Bertalanffy and motivated him to later establish a new transdisciplinary field. He was influenced by several philosophers as well as by results from experimental research. As a trained philosopher, Bertalanffy was clearly aware that the notion of systems has a long history going back at least to ancient Greek thinkers. As for the influences from science, the focus here will be on Paul A. Weiss and his experiments performed at the Biologische Versuchsanstalt in Vienna. Those two roots will be used to clarify Bertalanffy’s unique contributions towards a system approach in biology and beyond, in which the aim was to free the term system from vague or even obscure metaphysical connotations and arrive at a framework that is useful for science.

Keywords: Ludwig von Bertalanffy, organismic biology, system theory of life

INTRODUCTION
The general system approach of Ludwig von Bertalanffy (1901–1972) appeared chronologically after he already applied a “system theory” in biology. Nevertheless, already at the beginning of his scientific career, he was trans-disciplinarily oriented and concerned himself with the idea of integrating various levels of sciences. A major part of his PhD thesis on Gustav Fechner is on biology, although physics, psychology and sociology are also dealt with. He points out the “perpetual recurrence of the same in all levels of integration [Integrationssuten]” (Bertalanffy, 1926, p.49). Also in his later elaborations of his “general system theory” (GST), the levels of biology, psychology or psychiatry, and sociology resurface.

After graduating, Bertalanffy turned his focus on biology. Here, he developed what he called a “system theory of life” or “organismic” biology and made mayor contributions to establish the discipline of theoretical biology. Research in this field served as a nucleus for the later broadened system approach, and the early developments are thus important to understand the further research program of GST.

The current contribution is not comprehensive historical study, including discussions of critiques. Those who are interested in such details are referred to Pouvreau and Drack (2007), which describes why general systemology would be a more appropriate term than GST, and details influences on Bertalanffy and early developments made by him. Additional sources include Drack, Apfalter and Pouvreau (2007) and the PhD thesis of David Pouvreau. The focus here is rather on key aspects of the system approach in biology and how it is related to the further efforts in Bertalanffy’s work.
Bertalanffy’s early system approach

THE SUBSTRATE FOR AN ORGANISMIC BIOLOGY

Biological problems in the early 20th century

Besides general cultural problems associated with progress, also recognized as crises in the time after World War I, there was a phase of reorientation in physics, induced by confusing findings in quantum physics. In biology as well, conflicting approaches appeared; they culminated in the mechanism-vitalism-debate. The fundamental question was: Are biological appearances reducible to phenomena and laws of mechanics or physics and chemistry, or is life only explainable by assuming a specific vital entity?

The term “mechanicism” can refer to a complex of more or less coherently related positions. The more fundamental one is the “analytico-summative” approach to biological phenomena: the basis is the (methodological or metaphysical) postulate that any entity can be analysed in parts whose properties can be studied in isolation from the other ones without inconvenience (the relationships between the parts being “external,” not “constitutive”). Through decomposition into “independent” causal chains and their “linear” composition, the properties of the whole are then supposed to be derivable from the knowledge thus acquired. “Mechanicism” would be represented in a biology which combines the “analytico-summative” approach with one or more of the following positions: physicalism (the idea that solely the concepts, methods, and laws of physics and chemistry enable biological phenomena to be grasped), determinism (each state is univocally derivable from previous states), and “reactivism” (the changes in the behaviour of an entity are ascribable to the sole action of its environment) (Pouvreau, 2005b; Drack, Apfalter and Pouvreau, 2007).

“Vitalism” can have two meanings, a metaphysical or a methodological one. Metaphysically, it asserts that biological phenomena cannot be explained without the action of a nonspatia principle harmonizing the matter and energies involved in living phenomena. Methodologically, it is not antinaturalistic and only asserts that, at least provisionally, biology should have its own categories, methods, and laws (Pouvreau, 2005b; Drack, Apfalter and Pouvreau, 2007). Metaphysical vitalism renounces a scientific explanation.

This conflict was one motivation for Bertalanffy. Moreover, the ever growing number of results from experimental research in biology, which were rarely linked together let alone ordered in a comprehensive way, was a core incentive for him to establish a theoretical biology.

Some influences on Bertalanffy

Bertalanffy was influenced by many people from various disciplines. Those who are interesting here stem mainly from philosophy and biology. The PhD thesis of Bertalanffy was not only supervised by Moritz Schlick, the leading figure of the neo-positivist “Vienna Circle,” but also by Robert Reisinger, a prominent neo-Kantian. Bertalanffy was also in close contact with another neo-Kantian: Hans Vaihinger. Besides others, he was interested in Heraclitus, who said that “[a]ll things come about through opposition, and the universe flows like a river” (Barnes, 1987, p.107); in Cusanus, who wrote that in all parts the whole is reflected (Cusanus, 2002, p.45) and anticipated perspectivism (cf. coincidentia oppositorum); in Leibniz, who amongst other relevant issues anticipated a perspectivist approach when providing the example of one and the same town which looks different from different angles (Leibniz, 1998, §57); in Goethe, who was also important for many morphologists; and also in Nicolai Hartmann, who was writing about a stratified structure of the real world.

Bertalanffy was influenced by certain themes of philosophies of life (Lebensphilosophie) which comprised process, dynamics, creativity, and criticism of mechanistic thoughts. But
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he also distanced himself from certain other aspects in the philosophies of life and philosophies of wholeness (Ganzheitsphilosophie).

As for the influences from sciences, a few people can be mentioned. The considerations and experiments performed in the Biologische Versuchsanstalt by Paul Weiss, whom Bertalanffy personally knew, underlined the system theory of life. Weiss performed experiments in the field of animal behaviour and developmental biology.

The work in the field of Gestalt psychology was important, and here especially Wolfgang Köhler must be mentioned. Beyond psychology he introduced the concept of Gestalt also to physical problems (Köhler, 1924). This was important not only for “organismic” biology but also for the broadened “general systemology.” As a precursor of “general systemology”, the work of the mathematician Alfred Lotka (1925) was also important.

OUTLINE OF THE SYSTEM THEORY OF LIFE

General remarks

The conflict between “mechanicism” and “vitalism” is, for Bertalanffy, essentially metaphysical, and thus cannot be solved by means of empirical sciences.

Although there are machine-like structures or reactions in the organism, those are insufficient to explain life. In particular the experiments of Hans Driesch on early developmental stages of sea urchins were proving that the contemporary machine theory in biology must be false. He clearly demonstrated the equifinality of development, i.e., the arriving at similar final stages from different starting conditions. But his neo-vitalism based on those experiments soon disappeared.

What ultimately makes an organism an organism, or what is the difference between the living and the non-living? Bertalanffy was not satisfied with the mechanists’ approach on the one side and vitalistic currents on the other side. He notes that there are no “living” substances; rather, the basic trait of the living is the organisation of substances (Bertalanffy, 1934a, p.346). It is thus attempted to approach the core problems of life, namely order and organisation (a derivation of wholeness) in the organism. He concluded from analyzing theories of development, that “wholeness [Ganzheit], Gestalt, is the primary attribute of life” (Bertalanffy, 1928, p.225). Expressed in another way:

“The characteristic of life does not lie in a distinctiveness of single life processes [Lebensvorgänge], but rather in a certain order among all the processes” (Bertalanffy, 1934a). Observing events only separately will not reveal anything about the organisation of the organism. And biology must grasp the organism as a whole.

He tried to get closer to the problem by liberating “wholeness” [Ganzheit] from its metaphysical connotations and setting it to work at scientifically grasping life. Bertalanffy’s “organismic” biology or “system theory of life” was an attempt to overcome the conflict between mechanicism and vitalism in the realm of science (not ontology), and also to overcome the lack of a scientific theory of life. Accordingly, the organismic perspective also serves as a keystone in his effort to establish a theoretical biology, whose aim is to establish natural laws (system laws) for the phenomena of life. Those laws should be exact (as in other natural sciences) and reached deductively with the aid of mathematics. The organismic approach must be seen as a working hypothesis and not as an explanation; it raises a problem but is not a problem solution (Bertalanffy, 1934a; 1941a).
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In this regard, note that wholeness and holism is not the same. Bertalanffy insists that his “organismic” biology is not in line with holism. A leading figure of holism in Germany (A. Meyer) also points out the difference (Bertalanffy, 1941a, pp.341f.). In the same paper, however, Bertalanffy also clings up to the German regime and certain attitudes thereof.

“The organic wholeness [Ganzheit] is neither a metaphysical concept nor an asylum of ignorance, but a problem which can and must be investigated with the methods of exact science.” (Bertalanffy, 1930; 1937a)

Although Bertalanffy already writes about wholeness and systems in early papers, the meaning of the term system remained implicit for a long time. The explicit definition of the term was not presented before 1945, when a system was defined as a complex of elements in interaction (Bertalanffy, 1945).

In the Aristotelian “the whole is more than the sum of its parts,” the “more” is seen in the relations between the parts, which again shows the attempt to make way for a scientific approach: “The properties and modes of action of the higher levels are not explainable by the summation of the properties and modes of action of their components as studied only in isolation. But if we know all the components brought together and all the relations existing between them, then the higher levels are derivable from their components.” (Bertalanffy, 1932, p.99 and 1949a, p.140)

As knowing all the parts and their relations may sometimes be hard to achieve or even practically impossible, the search for laws of higher order is proposed. System laws should in this case show characters similar to statistical thermodynamics, where, although not dealing with causal events at the level of single parts, natural laws were found.

Above this system approach, the life sciences also ask for other perspectives which are beyond prevailing physicalistic issues. Thus, biology needs to be approached from different methodological perspectives, which are: physico-chemical, ganzheitlich or organismic, teleological, and historical (Bertalanffy, 1928, p.88).

Concerning the problem of finality, which is an ongoing problem in biology, Bertalanffy makes an interesting statement that reflects the different perspectives one can take: “What in the whole denotes a causal equilibrium process, appears for the part as a teleological event.” (Bertalanffy, 1929a, p.390; 1929b, p.102)

Basic concepts

Bertalanffy formulates what he terms two general organismic “principles” or “working hypotheses” (Bertalanffy 1932:331), which are rather conceptual models of biological organization. These “principles” had already been previously mentioned by several thinkers, but Bertalanffy unifies them and extends their scope from the single organism to biological organizations in general – from cell to biocenose. He thereby opened the way from organicism to systemism (cf. Drack, Apfalter and Pouvreau, 2007; Pouvreau and Drack, 2007).

The first is the “principle” of the organized system as an “open system” in “flux equilibrium” [Fließgleichgewicht] (Bertalanffy, 1929b, p.87; 1932, pp.83f., 116, 197; 1940a, p.521; 1940b, p.43). This equilibrium is different from the chemical equilibriums because the latter are characterized by a minimum of free energy. The organism, in contrast, is an open system that maintains itself through a continuous flux of matter and energy, by assimilation and dissimilation, and is distant from true equilibrium, and able to supply work. Thus metabolism appears as an essential property of the organism (cf. Drack, Apfalter and Pouvreau, 2007).
Bertalanffy’s early system approach

The second “principle” is the “striving of the organic Gestalt for a maximum of formness [Gestaltetheit]” (Bertalanffy, 1929b, p.104). This is meant to play a role in ontogenesis as well as in phylogeny, and later becomes the “principle of hierarchization” or “principle of progressive organization (or individualization)” (Bertalanffy, 1932, pp.269-274, 300-320). The dynamic interactions in the system give rise to order. This principle is very much related to epigenetic phenomena and comprises the development from an initial equipotential state (with maximum regulation abilities) over segregation processes. This is followed by differentiation and specialization, where some sort of centralization, with “leading parts” that control the development of other subsystems, can also occur. Characteristic is the inherent trend toward an ever-increasing complexity – a trend that he later (Bertalanffy, 1949a) calls “anamorphosis,” after Richard Woltereck had coined the term in 1940 (cf. Drack, Apfalter and Pouvreau). The “hierarchical” or stratified organisation was also used synonymously with the more neutral term Enkapsis (Bertalanffy, 1934a, pp.351f.).

Besides those two “principles,” a third one, namely that of primary activity of the organism, becomes explicit only later when Bertalanffy’s organismic thinking has matured (Bertalanffy, 1937b, pp.14, 133-134). It was nonetheless implicit in many of his writings between 1927 and 1932, and also has ancient roots. This concept must be viewed in opposition to a mere passive concept of organisms that merely react to the outside world.

We can thus numerate key issues of Bertalanffy’s thinking: “wholeness” was already mentioned in the last section; the open system in flux equilibrium; hierarchy and hierarchisation; primary activity; and, furthermore, the “conservation” of the integrity of the state of a system when it is disturbed from the outside, which is related to equifinality. All the issues reflect the dynamic understanding of the organism.

Some fields of application

Before testing the usefulness of his system approach in a broad field of sciences, Bertalanffy already applied his organismic perspective to deal with biological phenomena on various levels. He did not himself prove the usefulness in all fields of biology, but provided a means to approach phenomena differently. He gave the following explicit examples.

Morphology and physiology seemed to be two separate disciplines within biology. They therefore provided an area of tension to test the usefulness of the organismic approach. The origin of form in the organism is a key issue in biology. It is therefore understandable that Bertalanffy was interested in problems of morphology and developmental biology, and came up with a dynamic view in morphology (Bertalanffy, 1932, 1941a). He interpreted the phenomena as a hierarchic order of processes in a dynamic equilibrium, where the higher level system seems to be persistent [beharrend] while the subordinate level is in transition [im Wechsel]. He did not restrict this approach to the morphogenesis of an organism On the one hand he applied it to lower levels, where the cells are persistent while the chemical components are in transition. On the other hand, he also applied it to higher levels where, for instance, a biocoenose is persistent while there is a transition of individual organisms (Bertalanffy, 1941a). He claimed that the old distinction between form and function can essentially be reduced to the velocity of the processes in the organism: structures are prolonged and slow; functions are transitory and fast events (Bertalanffy, 1941a). The organismic form thus appears as a temporal cross section of a flow of events [Geschichtensfluss] in space and time.

But this qualitative model was still unsatisfactory to him. Within a dynamic morphology, Bertalanffy strove for exact quantitative laws. And he achieved this by connecting growth to the concept of open systems: An organism is growing as long as assimilation is higher than dissimilation, and a steady state [Fließgleichgewicht] is reached once assimilation and dissimilation become equally high. Through this approach, Bertalanffy tried to connect
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morphology, developmental biology, and physiology by means of a formal mathematical approach.

The single events, the exchange of components which are investigated by physiology, leave open the problem of organisation. This problem revolves around how all the processes are ordered, the connectedness amongst the processes. And a key problem of metabolism is that it is self controlled [Selbststeuerung] (Bertalanffy, 1941a, p.255). This calls for combining the issues. Although Bertalanffy’s work in this direction is not sufficient to explain all the phenomena, it was an important step towards investigating the order arising out of the single events.

The open systems approach was also a means to overcome the problem of equifinality, a problem raised by the experiments of Driesch which led to discussions about vitalism. Bertalanffy claimed that when an open system reaches a steady state, this state is equifinal or independent of the initial condition (Bertalanffy, 1940a); but there is some weakness in his related model, which in the premises already anticipates the results (Pourreau and Drack, 2007, p.319). A closed system cannot behave in an equifinal way.

Bertalanffy also approached the problem of homology, an important issue in biology. Transplantation experiments in developmental biology, especially Hans Spemann’s works on the “organizers of development,” are interesting in this regard. They show the dependency of each part on the position in the whole during the first developmental stages of the embryo. This demonstrates that the embryo must be grasped as a whole. The finding that in the experiment the same organ can develop from different material (taken from another place in the embryo) challenges the classical view, which holds that homologous organs stem from similar dispositions [Anlagen]. Bertalanffy tried to overcome this difficulty by means of a dynamic developmental homology concept [dynamisch-entwicklungs geschichtlicher Homologiebegriff]. This states that not the material from which the organ originates is decisive, but rather the organizing relationships through which the material is imprinted [geprägt] (Bertalanffy, 1941a, p.251).

Beyond the fields or problems where Bertalanffy utilized system concepts to a greater extent (e.g., growth), he also suggested an approach of wholeness or a system approach in other biological areas.

He for instance challenged the summative view in cell theory. This theory supposes that the organism is morphologically and physiologically the sum of cells and cell performances (Zelleistungen). Multicellular organisms appear as an aggregate of building blocks (Bausteins) termed cells. Of course, the cell is a basic structural element, but the organisation of a whole organism can be found in a single cell (unicellular organisms) as well as in the coordination of several cells (multicellular organisms). In the latter, the single cell plays another role, i.e., it is a part of a unit of higher order. Seen physiologically, life is not the sum of single cell performances. Those cell performances are also joined together to a unity on a higher level, e.g., by means of nerves or hormones (Bertalanffy, 1934a, pp.350f.).

Also on the level of the biocoenose or ecosystem, Bertalanffy envisages the wholeness of components that are interacting, although the degree of connectedness here is much lower than in the organism. The equilibrium in a biocoenose also involves a sort of steady state [Fließgleichgewicht], not of physico-chemical entities, but rather of units beyond the individual on a higher level of the system (Bertalanffy, 1941a, p.257).

The Darwinian selection scheme of evolution also appears to be “analytico-summative” (selection and summation of single modifications of separated traits) and “reactivist” (the phylogenetic adaptation of the organism is a mere reaction to the environment). If Darwin’s
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ing the key systems approaches for such emergent phenomena. If thinking was truly independent, then it could not be decomposable to the parts, and each part would change randomly and independently. Thus, the notion of selection (Selektionswert) is untenable. In the eye, for example, Bertalanffy (1934a) describes each part as necessary and senseless in isolation. Darwin’s theory is based on small changes of properties of an organism and presupposes the organisation. Bertalanffy (1934a, p.345) also points out that Darwin overlooked the difference in principle between property and part.

In this regard, note that Rupert Riedl, a former student of Bertalanffy, introduced a “system theory of evolution” which elaborates on the significance of the interdependence of genes by insertion of superimposed genes to transfer the functional dependencies within the structure of the phenotype to the genotype. A feedback between genotype and phenotype thereby increases the chances of successful adaptation (Riedl, 1977).

This brings us to genetics, where Bertalanffy also advocated a new view on empirical results. The prevailing summative interpretation should thereby be overcome by an organismic point of view: The chromosomes should not be seen as a chain of genes for red eyes and small wings (here he refers to early gene maps of the fruit fly), but rather the whole organism emerges [wird hervorgebracht] out of the whole genome; and genes are certain differences in the genome that account for different traits. Not the single gene itself creates a wing of this or that form. Rather the wing emerges out of the whole genome, and the shape can vary according to certain molecular differences in the chromosomes. Such a notion would circumvent contemporary problems of genetics, like the positions of the genes, while at the same time the results of genetics would not be contradicted (Bertalanffy, 1934a, p.359).

A field within biology which Bertalanffy surely influenced from a very early time on is what became known as ethology. This is a topic which he probably discussed with Paul Weiss already in the 1920s (Weiss, 1977; Drack, Apfalter and Pouvreau, 2007). Weiss was working in the Biologische Versuchsanstalt, a privately founded institution in Vienna devoted to grasp the big problems of biology experimentally. Weiss did research on animal behaviour, and falsified the mechanist tropism theory of Jacques Loeb (which comprises all four traits of mechanicism mentioned above) with experiments on the resting posture of butterflies with respect to light and gravity. What Weiss has basically shown is that the animal does not behave like a reacting “machine,” and that the resting posture can not be predicted by merely knowing the outside factors. The translated results of this PhD thesis from 1922 were published in the General Systems yearbook (Weiss, 1959). Weiss did not restrict himself to a systems approach in animal behaviour. He also used it in the area of developmental biology (e.g., Weiss, 1926) which influenced Bertalanffy who categorized the “field theory” in Weiss’s developmental biology as an organismic theory (Bertalanffy, 1928, pp.189f.). Weiss also extended his system thinking. Some articles should be mentioned which are still worthwhile reading: Weiss (1970, 1971). Also interesting are the contributions of Weiss, Bertalanffy and others in Koestler and Smythies (1969).

Konrad Lorenz, Nobel Prize winning ethologist, had a friendly relationship with Bertalanffy, as we can see from letters in the Bertalanffy archive (Bertalanffy papers). When writing a textbook on ethology (Lorenz, 1978) he very much stresses the system character and the importance of being aware of the wholeness when studying animal behaviour. Lorenz is not satisfied with behaviourism and he describes phenomena in animal behaviour that are not reactions to any outside stimulus and which can thus be interpreted as primary activity.

So already in the biological realm it is clear that Bertalanffy tries to apply system thinking on several levels. Interaction, hierarchization and steady state [Fließgleichgewicht] are utilized in areas from molecules to ecosystems.
Mathematical modelling

In the early writings of Bertalanffy mathematics was not seen as a proper means to deal with the complex problems in biology. Mathematics was looked upon as a tool to reduce biological problems to physics and chemistry. But this attitude changed considerably when recognizing that the mathematic approach is not necessarily connected to a reduction, but can rather serve as a tool to formulate system laws similar to the prominent example of Boltzmann’s statistical thermodynamics. Bertalanffy aims at the determination of “higher order statistics,” where the causalties driving the single parts are ignored, and “exact laws” are nevertheless derived without reduction to the realm of physics and chemistry. With his growth equations, Bertalanffy (1934b, 1941b) shows how a mathematical approach in that direction can be implemented in the field of the dynamics of morphogenesis (Pouvreau 2005a,b).

His approach was one beyond a mere data fitting and detecting correlation, but rather it was a hypothetic-deductive search for interrelations between relevant parameters, revealing the principles that underlie the processes, and finally arriving at natural laws instead of empirical rules.

Parallels in the models for individual animal growth and population development were already pointed out by several authors. But Bertalanffy found in Lotka (1925) (who was also influenced by Boltzmann’s statistical thermodynamics) an important precursor for his mathematical works and especially for the formal generalization when dealing with different empirical problems in a similar mathematical way towards exact system laws. This was approach was an important step in the way towards a “general systemology.”

The fact that Bertalanffy’s “organismic” biology was not an empty program is exemplified by his theory of organic growth, which even today remains a central reference. In this theory, the problems of global growth and relative (allometric) growth are tackled not only by finding growth constants, but also by linking growth with anabolism and catabolism. Animal growth is demonstrated to be the outcome of the openness of the system and of the dynamic interplay of internal driving “forces.” This step had not been made before, and combines the open system concept with equifinality and serves also as a bridge between morphogenesis and physiology (see Pouvreau 2005a,b; Pouvreau and Drack 2007). Furthermore, it was demonstrated that finding naturals laws in biology, independently of physics and chemistry, is feasible, and that thus biology stays as an autonomous discipline.

Epistemology

The “organismic” biology of Bertalanffy and further on his “general systemology” must primarily be seen as an epistemological program and not as a task of metaphysics. Nevertheless, certain objectivity is claimed to be reachable by means of a perspectivist epistemology. Perspectivism is a term coined by Nietzsche, and the approach finds its predecessors in Cusanus and Leibniz. Influences also came from Kant, Spengler, Vaihinger, Cassirer, Helmholtz, and also Piaget (Pouvreau and Drack, 2007).

The perspectivist approach is critical towards empiricism and must also be distinguished from realism. According to Bertalanffy it is possible to arrive at statements about some aspects of “reality” by looking at a “thing” from different points of view, like in perspectivism. In his own words:

“We are aware that no knowledge grasps the ultimate reality, and that it can only mirror some aspects of reality in more or less appropriate models. In the idea that every science is a mere reflection of certain traits of reality in necessarily limited symbols and models lie at the
same time the limit and the fruitfulness of the creative scientific thought. In contrast with the dogmatism of earlier times, we can call ‘perspectivist’ this world view and in that sense, the model represents the essence of every knowledge in general” (Bertalanffy, 1965).

“[..] perception is not a reflection of ‘real things’ (whatever their metaphysical status), and knowledge not a simple approximation to ‘truth’ or ‘reality.’ It is an interaction between knower and known, this dependent on a multiplicity of factors of a biological, psychological, cultural, linguistic, etc., nature. [...] This leads to a ‘perspective’ philosophy [...]” (Bertalanffy, 1969, p.xxii).

Physical constants are an example in which certain aspects of reality are represented (Bertalanffy, 1955, pp.258-259; 1937b, p.156). Taking into account different perspectives, i.e., different approaches, which all result in the same constants, an objective aspect of reality can be revealed. With his growth equations Bertalanffy exactly tried to find such constants in the realm of biology.

WAY TOWARDS A GENERAL SYSTEMOLOGY
The described concepts, methods, and epistemological background were opening the way for developing a general system approach.

With the formalism developed through the organismic program in theoretical biology, and the appearance of formal similarities in different fields, a broader, generalized scope could be taken into account. Though not all of the basic concepts of life are applicable broadly, at least some seemed to have the potential to be generalized and mathematically formulated. The open system concept is one example for a possible generalization; from the organismic realm towards systems in general. “General systemology” was presented first in 1937, its first print was in German (Bertalanffy, 1945; 1949b).

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Bertalanffy’s early system approach


Bertalanffy’s early system approach


Integrating Education and Mental Health Systems
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ABSTRACT
This paper outlines the development in Western Australia of integrated education and mental health services. A Process Model of Social Systems Design was employed to design new services to respond to the rising numbers of students with mental health problems. The significant changes that have taken place in Western Australia since 2004 to redesign systems, to bring together fragmented services and overcome interagency debates, are examined.

The Context
The Australian education system is larger and more inclusive now than ever before in its history. It continues to be dominated by government run schools, in August 2006, there were 9,612 schools in Australia, of which 71.8\% were government schools. In Western Australia (W.A.) we currently have 1123 schools with 376 425 full time students attending schools spread across a state that is approximately the collective size of Texas, the United Kingdom and Japan (see Figure 1).
A 2003 Survey of Disability, Ageing and 1the total school population in Australia (aged 0-14 years) had a reported disability (Australian Bureau of Statistics- Cat # 20014443.1) with more than two thirds of these students attending ordinary schools. W.A. has recently broadened its definition of disability with the legislation covering education, the School Education Act (1999), now including students with cognitive, neurological and psychiatric disabilities. “Pathways to the Future: A Report of the Review of Educational Services for Students with Disabilities in Government Schools” (Internal Department of Education and Training, WA report, 2004) identified the need for improved services for students who are identified as having a psychiatric disability. Without the benefit of a federal legislation1 that specifies the terminology, and accompanying descriptions in this area, the various states and territories have developed their own diverse range of criteria for a psychiatric disability and the corresponding services.

The Micro-system
I was exposed to systems theory in my undergraduate degree (1980s) at Murdoch University, W.A. Early in my career in education (1990s) I met and worked with the co-author at a day patient facility for young adolescents with severe emotional disturbance, now known as the Andrew Relph Centre. The centre was established in 1982 and is based on a systems view of understanding and intervening with young adolescents with

![Figure 2. School related problems](image-url)
emotional problems. The three frames (see Figure 2) that are considered to apply to children with severe emotional disturbance are the school sub-system, the peer sub-system and the family sub-system (Boultwood, Wheatley and Gardiner, 1993). The program attempts to intervene in all three sub-systems but, perhaps more importantly, also considers the interface of these sub-systems. “Without these ‘imaginary frames’, or systems, the amount and variety of available information often threatens to overwhelm the potential change agent” (Relph, 1984, p.118). The focus on the interaction between the three sub-systems is deemed to be vital to the success of interventions implemented within the program.

*The Macro system*

By 2004 I was in a position to be an agent of change in the Western Australian education system. As part of a small team I completed a review of education services for students with disabilities in government schools, the most comprehensive review of such services conducted in W.A. in over 20 years. Subsequently, the “Pathways to the Future” report was released in February 2004; and by April 2004 the W.A. state government announced an additional $AUD 40 million budget over 4 years to further support students with disabilities and learning difficulties.

That same year I took up an appointment as the Principal of Hospital School Services (HSS), an education service that operates over 30 programs for students with medical and mental health issues (inclusive of the Andrew Relph Centre) jointly with the Department of Health. In May of 2004 I proposed a follow up examination of services for students with psychiatric disabilities. During 2005 the second author and myself released the report “Educational Services for Students With Psychiatric Disabilities in Government Schools” (report available from the first author) and its’ recommendations were endorsed by the Director General of the Department of Education and Training (DET).

Since the release of the report into the education of students with psychiatric disabilities the following outcomes have been achieved in W.A.:
Integrating Education and Mental Health Systems

- Severe Mental Disorder is now a defined disability group and 124 students have so far been identified as meeting the criteria.
- DET provides supplementary support in terms of teacher time and/or educational assistant time to students with Severe Mental Disorders, at an approximate cost of $AUD 2 million per year.
- Collaboration with each of the metropolitan Child and Adolescent Mental Health Services (CAMHS) in identification, referral and management is actively supported through five dedicated teacher liaison positions.
- A specialist mental health professional has been contracted from CAMHS to support the understanding in DET personnel of severe mental disorder and implement risk management processes for schools when dealing with students presenting high risk and suspected of having a Severe Mental Disorder.
- Three Mental Health and Education Steering committees have been formed to support interagency practices and establish a strategic plan for the provision of intensive assessment and management for students with Severe Mental Disorders.

Based on this work I was awarded a Churchill Fellowship\textsuperscript{ii} in 2005. The fellowship allowed me to meet with a wide range of experienced and knowledgeable people in a number of countries to explore a range of programs dealing with the educational needs of children and adolescents with mental health problems. The CEO of the Fellowship Trust has recently signed off the report on my travel to the UK, Sweden and the Canada in 2006. Most recommendations from that report have been funded and implemented by DET (a copy of the findings are available at the Churchill Fellowships Australia website at http://www.churchilltrust.com.au/res/File/Fellow_Reports/).

Relph (1984 p. 119) summarises the need for a second order cybernetics approach, “…a change agent cannot be seen as standing outside the system. Instead, the change agent must join the systems, be subject to their powers and pressures, and by his or her presence introduce a difference that provides a catalyst for change.” The authors have maintained their positions within the systems and have applied Banathy and Jenlick’s
Integrating Education and Mental Health Systems

“Process Model of Social Systems Design” (1969, p. 48) to integrate the Education and Mental Health systems of W.A. to improve the support for students with psychiatric disabilities.

PROCESS MODEL OF SOCIAL SYSTEMS DESIGN
Transcending the Existing State

As indicated, Psychiatric disability had not previously been identified as a disability within the Western Australian Education Act, prior to the 1999 revision. The DET around this time began the Psychological Health Trial to provide additional educational assistant\textsuperscript{iii} time to schools for students with psychological health issues but there was no requirement for ongoing collaboration with treating mental health services. As part of District Education Services, DET employs approximately 180 school psychologists (registered psychologists with an educational qualification) these psychologists work at individual and group levels, with staff, students and parents in the area of learning, behaviour and social/ emotional well being but have no formal link to the mental health system. Thus the existing state in W.A. was two systems operating separately without systemic levels of collaboration (see Figure 3, Model 1).

The one exception to that lack of systemic collaboration (see Model 1 in Figure 3) was Hospital School Services, which operates a number of mental health programs jointly with Department of Health:

- Families At Work is a state-wide tertiary residential program at Bentley Hospital for primary aged students.
- The Education Pathway program of Family Pathways is for primary aged students and adopts a multi-modal approach.
- The Princess Margaret Hospital (PMH), Ward 4H is an 8 bed acute residential unit for all school aged students who require short stay assessment and/or treatment.
- The Transition unit at Bentley Health Service is based on a recovery model for both inpatients and outpatient of secondary school age.
- The Andrew Relph Centre is a day program for students transitioning from primary to secondary school.
Integrating Education and Mental Health Systems

- The Eating Disorders Unit is an intensive treatment program at PMH for inpatients and outpatients.
- The Paediatric Consultation Liaison Team at PMH caters for a range of inpatients and outpatients with acute and chronic health conditions.

However, the HSS model of service delivery until 2004 was based on the Department of Health (DoH) being the lead agent (see Model 2, Figure 3) and HSS staff supporting the educational provision in programs run by DoH.

![Figure 3. Competing models for systems interaction.](image)

Envisioning: Creating the First Image.

The examination the authors conducted in 2004 clearly indicated that W.A. needed a collaborative model of service delivery for the high numbers of students with psychiatric disabilities in its schools. Other states in Australia for example, the New South Wales State education system terms psychiatric disability as an Emotional Disability and includes students in this group within their segregated educational settings (Center, Ferguson & Ward, 1988). But in a state priding itself on inclusive education practice this was not a model for WA. The Victorian State education system terms psychiatric disability as a Behaviour Disability and has been trialling a “CAMHS in School” model.
Integrating Education and Mental Health Systems

where Mental Health practitioners provide comprehensive screening, assessment and intervention within the school system (Corboy & McDonald, 2007). Rather than adopt another Model 2 level of intervention (See Figure 3) the Department of Education and Training took the initiative to integrate the services (Model 3, Figure 3) of the two systems by adopting the following Envisioning principles:

- The government system has a significant and expanding role to play in the identification of mental health problems in children and adolescents.
- The government education system is not mandated for, nor does it have the appropriate resources, to provide sole treatment for mental health problems in children, adolescents or parents.
- The government education system has a legislative and ethical obligation to provide access to the curriculum for school-aged children and adolescents that is appropriate to their current level of mental health.

Designing the New System Based on the Image

As there had been no definition nor criteria for service delivery, prior to 2004 for students with psychiatric disabilities in W.A., it was initiated that DET formally accept a psychiatric disability category termed Severe Mental Disorder. This was done to promote communication and collaboration between the DET and the DoH by DET adopting the
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terminology used in the DoH to refer to students with psychiatric disorders as articulated in the *Infancy to Young Adulthood: Mental Health Policy for Western Australia* (2002).

From focus group exploration by the authors the lack of effective communication and collaboration between Education and Mental Health services was seen as the fundamental issue in service delivery (Figure 4.). Based on the *Envisioning Principles*, HSS established a CAMHS and Education Liaison Team (CELT) with initially two teacher positions appointed in 2005 across 4 of the CAMHS clinics in the Perth metropolitan area. The CELT teacher role was designed to ensure high levels of consultation and liaison between school staff, School Psychology Services and CAMHS clinics, while maintaining the primary treatment role of CAMHS. Thus the poor relationship indicated in Figure 4 could be bridged and the two systems joined as per Figure 5.

An independent review by Associate Professor Jenkins of Curtin University (Unpublished Report available form the first author, 2006) found that “…implementation of the model has led to improved communication, the development of more informed individual care plans, greater inter-agency collaboration and improved advocacy and management of the health and educational needs of students with mental health disorders”. There are now a total of 5 CELT teachers working in all of the 11 CAMHS across the Perth (Western Australia’s capital city) metropolitan area.

Transforming the System Based on the Design

Collaborative practices are now well documented as increasing effectiveness and efficiency in response to service needs (Miller & Ahmad, 2000). Further, the issues for Education systems not engaging Mental Health services in effective collaboration are evident. Rones and Hoagwood, (2000) found that schools in the United States functioned as the de-facto mental health system with less than 45% of students with psychiatric disability receiving services other than through the school. However, the authors’ goal was not just to add additional services but to transform the system of support for students with psychiatric disabilities through the Process Model of Social Systems design and there are a number of indications that this has been achieved. Moretti et al. (1997),
emphasize that, “when services are not integrated with a common goal, a common paradigm for understanding the social problem, a common language of how to work together, families and children fall prey to fragmented services and interagency debates about mandates and responsibilities” (p. 646).

The two systems, DET and CAMHS now share some common goals, for instance the CELT model is well established in the metropolitan area of W.A. and the two systems, in collaboration, are now looking at the rest of the vast state to propose joint models in response to the high need and low levels of support in rural and remote areas. A Mental health Intervention Team is to be established by HSS during the 2007/8 financial year to provide a fly in fly out service to rural WA. The team will commence utilising a DET seconded mental health professional from the CAMHS sector as the Team’s Leader but the two systems are in close collaboration on how the team will function and in negotiation as to how CAMHS could fund the Team Leader role in the future.

To illustrate the willingness to adopt the same paradigm the two systems have recently applied for and received a joint budget to fund innovative practice between the two systems. The established criteria for the funding are as follows:

- Enhancement or improvement of collaborative efforts between school-based and mental health services.
- Enhancement of the availability of crisis intervention and appropriateness of referrals.
- Provision of training for the school personnel and mental health professionals.
- Provision of assistance and consultation to school and mental health systems and families.
- Provision of linguistically appropriate and culturally competent services.
- Evaluation of the effectiveness of the program in increasing student access to quality mental health services.

Finally, finding a common language of how two large, complex systems can work together is illustrated by the recent launch in WA by the Minister for Education, of an
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initiative to open three educational withdrawal centres for students who present major behavioural challenges. The Education and CAMHS systems have to date had varied understandings of behavioural problems. In Mental Health services, behavioural problems are seen as part of a continuum that features both internalising and externalising dimensions. The issue arises for schools when no diagnosis is sought nor considered relevant as to how students with challenging behaviour are distinguished from those with precursor mental health disorders. Despite this difference, the language barriers of each of the three Mental Health and Education Steering Committees have been overcome to propose the two agencies work together to achieve the Minister’s vision.

References
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Footnotes

\(^{i}\) Unlike the United States of America (Individuals with Disabilities Education Act) and the United Kingdom (Education Act 2002), Australia does not have federal (i.e. country wide) laws governing the education for students with disabilities.

\(^{ii}\) The Churchill Fellowship program is a grant program that provides financial support to enable Australian citizens to travel overseas to undertake an analysis, study or investigation of a project or an issue that cannot be readily undertaken in Australia (http://www.churchilltrust.com.au).

\(^{iii}\) Education Assistants are paraprofessionals within the W.A. education system who provide additional support to teachers in classrooms.
greenhouse: An Integrated Knowledge System for Teachers

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ABSTRACT

This paper outlines the development in Western Australia of an environment for sharing knowledge about teaching students experiencing difficulties with learning. Systems design was employed to build an online environment integrating tiers of knowledge of increasing complexity, and to provide learning opportunities for teachers in peer learning environments that support the rapid spread of good practice built on evidence-based knowledge. Since 2004 the project has utilised a Federal grant to address the professional development needs of both public and parochial teachers in a state of Australia the geographic size of most countries. This environment for professional learning and innovation is called greenhouse and has created a climate for communities of practice and currently has over one thousand five hundred members.

Traditional educational institutions are under pressure to be more responsive, efficient, and to deliver a higher quality of teaching. Current systems of education were developed over many years to respond appropriately to a world that is now fast disappearing. Teachers are increasingly required to adapt to meet changing external conditions, administrative complexity and to respond to individual student’s needs. In addition to developing, maintaining and disseminating subject expertise, teachers now take on the role of facilitator of learning. Thus developing teachers’ skills becomes a broad endeavour, as individualised as the programs that teachers may design for their students.

In 2003 the project partners, the Catholic Education Office, the Department of Education and Training and the Association of Independent Schools of Western Australia put forth a proposal from Western Australia for funding under the Australian Government, Department of Education, Science and Training (DEST) National Literacy and Numeracy Strategies and Projects Program. The aim of the proposal was to develop an online resource (named greenhouse) to provide teacher development on up to date information on learning difficulties related to literacy.
The first author wrote the proposal for the DEST funding and applied a systemic philosophy to the project proposal. Once the funds were received a wide cross section of educators from all sectors of education in Western Australia became involved in the program’s implementation committee. KT Studio, a design team led by the second author, was contracted to design and build the online system. The second author has a background in cybernetics and his team integrates systemic thinking into their web engineering. The match between the web engineering and the project design allowed for a new system’s approach to teacher professional development being devised. To achieve this the authors accepted the challenge to the education technology community set by Bathany and Jenlink (2004):

- We must transcend the constraints and limits of the means and methods of instructional technology.
- We must develop open systems thinking, acquire a systems view, and develop competence in systems design.
- We must create programs and resources that enable our larger educational community to develop systems thinking, a systems view and competence in systems design.
- We must assist our communities across the nation to engage in the design and development of their systems of learning and human development.

Transcending.
Models for enabling transformation are emerging in many fields, and new approaches have led to significant advancements in adapting to the new needs of our society. In the area of computer software development, for example, by releasing the operating system Linux as open source i.e. available free-of-charge to anyone, open source communities have sprung up world wide to share, collaborate and operate as communities of interest. These communities and the way in which they work have completely transformed the computer software industry.

In creating an education system that transcends current instructional technology it is important to recognise that trying to
improve the system incrementally from the top down yields decreasing returns:

- Changes imposed by management or government strategy often do not work as planned.
- Teachers providing a content laden curriculum rather than facilitating the learning needs of students leads to disengaged students failing to learn the basics.
- Education systems imposing professional development on teachers that does not allow “just in time” access and self-paced learning, has meant teachers only participate when it is mandated and fail to engage in innovative practice.

Even then, as depicted in the diagram left, the top down material supplied was primarily provided to create a tension with the top down knowledge so that the true professional development needs of teachers were uncovered. Once these needs were discovered the implementation team contracted top down and bottom up practitioners to work together to provide interactive modules of professional learning to small groups of enrolled teachers.

**TRIGGER QUESTION**

In creating an education system that is relevant to the modern world and one that is responsive to change and innovation, it is important to recognise that trying to improve the system solely from the top down yields decreasing returns. In education systems where change from the bottom up is often discouraged how can new responses be encouraged?

**Systems design.**

As discussed the aim of *greenhouse* is to bridge the gap between that which a teacher recognises as a professional knowledge need, and the wealth of resources available, including peer expertise and academic (tacit) knowledge. In *greenhouse*, teachers both access and provide information to the
knowledge resource, and participate in a learning community. Thus the greenhouse environment also responds to the need that many teachers experience – the need for, collaboration. The design of the environment allows for the development of open systems thinking by supporting the dynamic creation, development and maintenance of communities of practice. Even when a teacher knows that what they are doing is good practice, the means of sharing this with other teachers and other schools can be limited. Through greenhouse the teacher readily receives feedback to keep the system of knowledge creation open.

greenhouse offers an environment in which teachers can build secure, trusting relationships. This is essential so that they are prepared to interact, take risks and learn from occasional failure. As a profession, teachers lack the opportunity or the support systems to leverage innovation across the profession in ways that other professions (such as medicine) have demonstrated. greenhouse has proven that teachers will interact with peers and others if a shared interest is identified and they are in a secure environment. This occurs where discussions and outcomes are documented in topic-specific based forums which are regularly moderated by a professional who has been trained in the importance of maintaining a system’s boundary but allowing the right amount of permeable knowledge. This training and subsequent success in moderation became the method by which competence in systems design was tested by the project.

TRIGGER QUESTION
There is evidence from research (Bourne and Moore, 2005) into online teaching and learning that illustrates that considerable effort is often required to get individuals, particularly those over 30 years of age, to voluntarily engage in online group communication. How then can we design education systems that encourage teachers to utilise such technology especially where it requires them to expose, in their view, their ignorance about a topic or issue?

Community.
Education systems make considerable investment into the professional development of teachers, and greenhouse provides an example of instructional technology in which teachers can ‘value-add’ to that investment, whether it is by participating in a discussion stream to clarify and challenge, or by contributing expert knowledge. The greenhouse environment was designed to provide a sustainable level
of materials, so that ‘just-in-time’ learning is a natural expectation for members of the community. Teachers and other users do need to attend training in matters that are not relevant to their practice at that time, but when the need arises, they participate in greenhouse to discover the knowledge, resources or support that they require. Being needs-based, this form of knowledge acquisition is economical, focussed, and an effective use of teachers’ time as it promotes learning in an ever deeper way.

**TRIGGER QUESTION**

*How can an education system be designed that allows for knowledge to function as an attractor and build nodes of knowledge and activity?*

greenhouse aims to supplement, tune and focus resources around the real needs of teachers in the classroom. A highly significant value of greenhouse comes from the capacity to form a community of practice for teachers. Wenger (2004) defines communities of practice (CoP) as ‘groups of people who share a passion for something that they know how to do, and who interact regularly in order to learn how to do it better.’ Multiple communities of practice have been created within the greenhouse environment. These communities are fluid, with members joining and leaving. Each coherent and sustainable community drives the energy of the discussion and ‘tunes’ the relevance of the topics, materials and knowledge available. Depending on the issues that are of priority to a community, the focus will change and new communities of practice are created.

A community of practice may thus be established to focus on almost any area of interest. Its principal objectives (Nickols, 2003) usually are to:

- enable community members to learn from each other through the sharing of lessons learned, problems and their solutions, ideas, etc.,
- share the learning that occurs in the community of practice with others, and to
- generate benefits (e.g. economic, social, environmental, problem solving, etc.) to the organisations and members forming part of the community of practice

Richness in a community of practice is provided by the existence of many different discussion threads. These threads grow around seeds/ideas that have been contributed. Teachers and others who
participate are attracted to the ideas both to initiate debate and to act as catalysts for new ideas. The community itself continually develops new seeds and in this way the teachers participating develop systems thinking through the holistic development of the environment.

The next online environment was founded around the need for teachers to support students who were gifted and talented. That community was based on the same systems design but commenced as an online conference that spanned the world with its speakers and participants. Following that an online environment for teachers of students with disabilities was created. Thus, new environments were created by KT Studios as the needs of the participants significantly diverged from the previous, although each contained the seed of design from the initial greenhouse project. Ultimately the Professional Learning Institute of DET WA employed KT studios to build an encompassing environment for all teachers’ professional development in WA that embraces the same systems design as originated with greenhouse.

As a federally funded project, greenhouse is awaiting formal approval to launch. Despite this it currently has over one thousand five hundred members. Nationwide interest has been generated with the Northern Territory of Australia recognising the potential for greenhouse to reach its teachers, whom face even greater geographic isolation than those in Western Australia. Further, the DEST, faced with the roll out of professional development in the area of disability
standards, approached the authors to discuss design aspects for online professional communities. Neither of these projects have come to fruition but the seeds of system design, to transcend the constraints and limits of the means and methods of instructional technology, have been sown.

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Wenger (2004)

Notes

Feedback
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THE USES OF THE SYSTEMIC-CYBERNETIC APPROACH IN HUMAN AFFAIRS: A CALL FOR PRACTICE

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ABSTRACT

It is surprising to see - after more than 50 years of theoretical developments and quite a number of papers dedicated by systemists to practical complex situations - that the systemic-cybernetic approach to global messes (as typified by R. Ackoff) is still widely ignored by most leaders in business, economics, syndical unions, administration and politics (at any level), and even non-governmental organizations. This is a discouraging story of missed opportunities for a better management of human affairs in general, avoiding disasters or creating new possibilities through a keener understanding of the past and a wider appreciation of future possibilities, whether negative or positive.

The paper is an attempt to define a methodology for the practical use of the systemic-cybernetic global array of tools and models

Keywords: Cybernetics - Global messes - Synergies - Systemic approach

THE GLOBAL MESSES WE ARE UNWITTINGLY CREATING

At this beginning of a new millennium it seems that we are growingly mired - worldwide - within an unending chain of more or less global problems of the most varied types, already in full swing, or as growing menaces:

Wars between nations and civil wars
Racial pogroms and discrimination
Growing masses of destitute and very poor people worldwide (even if more and more other people are also becoming prosperous… within the global of a planetary demographic expansion)
Man made ecological degradation
- extinction of numerous terrestrial and marine vegetal and animal species
- growing contamination of the seas and oceans
- salinization of wide areas due to ill-managed irrigation

Financial unstabilities
- Wide unsolvencies crises due to imprudent uses of credit
- Currencies crises and their worldwide effects

Climate growing uncertainties
- Possible results of the planet’s global warming as a result mainly of the massive use of non-renewable fossil fuels. This includes:
  - North and south polar ice accelerating disappearance
  - Increase of the level of oceans, starting worldly
  - Expanding desertisation (in Africa, both Americas, Asia and Australia)
  - Shifting of climatic zones that begins to perturbate agricultural uses
A Call for Practice

Demographic explosion in the 20th C., which, if combined with expanding birth control technique, leads to a wide desequilibrium of the pyramid of age classes, with possible dramatic results, mainly in Asia and Africa during the later 21st Century.

Ever more difficult management and control of the multiplying megalopolis in all continents (London, Shanghai, México, Cairo, Sao Paulo, New York, etc…) (closely related with technical progress in agriculture that leads to massive migration of peasants toward the great urban areas)

Even positive developments that entail in some cases negative - and generally unpredicted - consequences…
- Growing biological resistance of pests to chemical control
- Increasing demographic and socio-economic load on active population of non directly productive people: students, jobless people, retired persons (as an optimum result of better life conditions and medicare!)

It should be noted that, even enunciated in categories, ALL these problems are more or less interconnected and synergizing.

Proposals for a general program of good behavioral practices
All of these unsettling situations and perspectives are man-made. And in many of them, each of us is an active contributor, even at a small scale…. The author of this note and his readers included … for example using our fossil fueled cars.

Accordingly, it seems extremely urgent - if we don’t want to totally lose control of our conditions of existence on this unique planet we have - that we should instaure a global code of good conduct in order to avoid the dangers resulting of our present general mismanagement.
The following steps in an orderly way seem to be necessary.

Elaborate adequate models of complex situations
A very general feature of human action is short term pinpointed intervention without much consideration for environmental conditions and possible side-effects. This becomes in many cases a recipe for trouble and even great disasters. Such an attitude is a result of our generally simple and linear way of thinking, by linking only one cause with one effect at one specific moment..

In fact, in most real situations, many more or less interacting and more or less repetitive or permanent effects do result from many more or less interconnected causes within a complex background. Most people will acknowledge this as an obvious reality… but will also forget to take it effectively into account in practice.

It is interesting to go back in time and read what Descartes - that father of modern rationalism - did say in his “Discours de la Méthode”. His purposes and proposals were as follows:
“…to divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution.
“… to conduct my thoughts in such order that by beginning with objects the simplest and the easiest to know, I might ascend by little and little and, as it were, step by step, to the knowledge of the more complex, assigning in thought a certain order even to these objects which in their own nature do not stand in relation of antecedents and sequence
A Call for Practice

“… In every case to make enumerations so complete, and reviews so general, that I might be assured that nothing was omitted”

Unfortunately, Descartes proposed at the same time the step by step reasoning mode of geometry as the suitable model for reasoning in general. Such a precept contains in fact the seeds of the whole reductionist research method, of extraordinary efficiency when applied to phenomena really reducible to a simple sequence of elemental facts and/or separable parts, but which inconveniently eliminates the complex and frequently simultaneous interactions between elements and processes.

As a result we end up with a kind of anatomy of situations where in fact we should need a physiology of coherent action. Metaphorically, we kill the patient and dissect him in order to diagnose his illness.

What we really need is a methodology and guiding lines to establish correct models of evolving complex situations. This includes not only all the elements and every process, but moreover also a description as complete as possible of all their simultaneous and sequential interactions. This is obviously a very tall order. Moreover, the modeller will always remain confined by his/her own conceptual and material limitations. Accordingly, in practice such models can never be perfect, but only, as much perfectible as possible within the limits of the available means.

Looking for the natural feedbacks and man introduced controls

Any complex situation is characterized by a set of specifically restricted conditions, reflected in natural feedbacks, which canalize and maintain processes within limits in accordance to environmental settings and internal need for non-contradiction and harmonization.

As a result, more or less regular oscillations of multiple parameters are generally observable…. and should be observed and monitored, in order to understand what is going on and, eventually, how and when the situation may escape out of its normal channel, becoming thus unstable and possibly dangerous. Of course, only a well conceived model can help us in such an endeavour, including precise observable processes, warning signals and checkpoints.

Selecting and establishing these may be in itself an arduous guessing task because it must be undertaken by trial and error correction, precisely when the situation is still quite ill-understood.

On the other hand, what is observed must be interpreted within our personal frames of references. This introduces a real possibility of misunderstandings due to faulty reasoning or prejudices. (Theory of sets, Peirce’s semiotics, Venn diagrams, Maruyama’s mindscape, Korzybski’s general semantics and a number of other related concepts can be quite helpful in such a matter).

When finally a supposedly satisfactory evaluation of the factual state of affairs has been reached, it is still quite probable that changes should be needed, i.e. that man-made controls should be installed. This is again a tricky business that should be carefully managed because it also implies psychological and conceptual evaluations as well as factual and technical limitations. Without getting to the extreme position “If it works, don’t touch it”, any would be reformer should ask himself: “What could go wrong if I start tinkering with this structure or that natural feedback”. Such carefulness is unfortunately infrequent, as most people are merely interested in inmediate and short-term benefits without consideration for future eventual mishaps, particularly when other people would have to pay for them, and in a more or less far away place or future.
**A Call for Practice**

**Evaluate the workings and effects of these feedback and controls**

The foregoing comments also introduce the need for a methodology of monitoring complex situations and the effects of our own management of the same.

Even the best conceived interventions in a given situation may produce unforeseen consequences for the project itself and, or for the environment, by and large.

This subject has been widely explored by Michael Jackson, under the general concept of “creative holism”, as a systemic approach to management.

Among other aspects of monitoring complex situations, one is of foremost importance, i.e. the detection of early signals of any erratic or abnormal behavior of the system under observation. As said by a French popular dictum, “there is no smoke without a fire” (but of course a “fire” may be smouldering for some time before any “smoke” can be observed).

We should thus face two successive conundrums. The first one is: what kind of signals, or forewarnings should be monitored for any specific evolving situation, and thus observed as early as possible. Guidelines could be useful, but their accuracy depends largely on historical experience and on observers attentive acumen.

And the second one is: how best can we understand and interpret eventually such observed signals. This also remains true when observing the results of our eventual management interventions, as any of these, if not suitable, can easily derail any process.

It is also well known that an early correction of any deviation is much less costly than a belated one. However, in any dubious circumstances, the “just in case” and the “just in time” interventions should be thoughtfully considered, while all possible options should remain open as long as possible.

**If not suitable modify them and, or introduce new ones**

Of course, in many cases we have to face unsatisfactory situations and accept the need to introduce changes into some system which seems (to us!) to be ill-working. This is in many cases a tricky business because specific or local changes generally produce effects - not necessarily always positive - in other parts or processes in the system. Moreover, such effects are frequently delayed in time and thus impossible to observe early. This limits us merely to the recourse to hopefully educated guesses.

Moreover let us remember that many self appointed reformers ended up in dead ends or becoming mere sorcerer’s apprentices… and some even condemned to be burnt at some real or symbolic stake.

Accordingly, it would be advisable to design general criteria related to the dynamics of possible and proposed change in complex situations and systems. Tentative guidelines could be for example:
- which would be the best technical way to introduce the proposed change
- which qualitative gains can we expect
- which quantitative gains can we expect
- which negative effects could appear… and when
- could there be negative psychological or social reactions to the proposed change
- … and even, what could be a significant, but ignored problem!

… To put it shortly, let us beware of intellectual insolence or self-sufficiency
A Call for Practice

Monitoring the results

In order to achieve a reasonable measure of security and responsibility, it would be advisable to frequently check the practical results of our interventions. This can be done using a re-worded version of our former guidelines, as for instance:

- Does the used technique of change work satisfactorily? Is it cost effective?
- What are the prognoses of the modified process and situation?
- Could some unexpected effect be surfacing? Which ones, specifically?
- Should something be amended, or replaced?
- How does the benefits and costs balance evolve?
- Which are the psychological and social reactions of the stakeholders (i.e. all those people in some way affected by the changes)?

And, most significantly, this sequence of activities and evaluations should be frequently rerun: Monitoring should be more or less permanent or, at least periodic.

Problems with the management of the “problems”

Of course, there is a very important and difficult psycho-sociological problem occult in this sequence. Valorating terms have been used in this short note: “adequate”, “natural”, “suitable”… and even “evaluate” and “monitor”, and “frequently”.

The catch is that anyone has her/his own understanding of what should be considered “adequate”, etc… and her/his own way to “evaluate” and decide what should be “monitored”… and why, and how, and when, and by whom.

We thus have to discuss our criteria widely and universally… which is for sure a very demanding task, as can be observed in the deep and wide controversies about nearly every situation or project discussed in the numerous international organizations that sprang up during the second half of the 20th Century (even if the very emergence of such organizations is per se a quite useful and positive first step)

All this is again a very intricated conundrum. The progress and the results of any significant project affecting many people should ideally be submitted to public opinion. But the citizenry is generally not well informed. And, if duly informed, common people generally lack the basic knowledge needed for sound appraisal and, in many cases show no interest whatsoever.

However this should not be used as an excuse for non-consultative autocratic management. Much progress toward better public information and understanding has taken place worldwide during the 20th Century and this should remain an ongoing progressive endeavour.
A Call for Practice

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FUNDAMENTALS OF RELATIONAL COMPLEXITY THEORY

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ABSTRACT
“Relational Complexity” is emerging as a new science that can explain the origin of both the living and non-living world. Its basic tenants are quite simple, but controversial due to prior limits on scientific thinking, particularly the mechanistic world view. In this new view, both living systems and mechanisms emerge as special cases of the general, relational complexity. The basic relationship is between existent and potential aspects of nature, which is an information relation crossing the subject-object boundary. The theory is compatible with both Western and Eastern thought and offers a means to integrate these quintessentially opposite world views. It can also provide a solid theoretical foundation for structure-function epistemology in ecology that is not predicated on, or thus limited by, mechanistic assumptions.

Keywords: Complexity, relation, nature, living, systems, ontology

INTRODUCTION
A new science of creative natural relations may be emerging from Western systems theory. Its foundation, called “relational complexity,” was rigorously formalized by the late Dr. Robert Rosen between 1972 and 1999, in his quest to answer the question “what is life itself?” The theoretical foundation of relational complexity theory constitutes a new way of seeing nature in terms of pre-mechanistic information relations between realized and potential systems informing each other (Kineman 2007a). In this view one does not imagine life emerging from a special arrangement of mechanisms, but rather life and mechanism identify special cases of an information relation. The resulting view of the natural world thus includes the mechanistic, but is radically and profoundly broader in its more general entailment. As an analytical framework, it is capable of representing origins and seemingly vital and teleological aspects of nature, without returning to pre-scientific concepts that became logically untenable in prior views.

In modern science we now realize that description cannot ultimately be purged of subjectivity even though it requires objectivity. Rosen’s genius was to accept both facts and thus to incorporate subjectivity into his view of nature, as an expansion rather than a replacement of the mechanistic world view. In the finest tradition of integral thinking, which Einstein described of his own method of arriving at relativity theory (Einstein 1924), Rosen constructed a theory that holds two seemingly contradictory but inescapable facts of modern science to both be true, thereby producing a higher order synthesis. The two thus paradoxical facts of science that were reconciled are: (a) collective states of nature depend on prior states, and (b) isolated states of nature depend on perception. The kind of description or analysis that results from combining these conclusions treats perception itself as part of nature (a basis for ‘mind’) and thus perception is a necessary part of our description of nature. Many others in modern science and throughout antiquity have hinted at this basic relationship. Science itself is a natural phenomenon in this view, being a human realization of a “modelling relation” (Rosen 1991).
Foundations of Relational Complexity

Here I describe the fundamental tenants of this new science, as a synthesis of ideas presented in other papers and in Rosen’s work. A basic synthesis is needed to establish programs of research and education in this new field. It is very important in any new science that those exploring it agree on working assumptions at the outset, to form a community that can progress according to a common line of inquiry. Too often in system science, and certainly in studies of complexity, life, and consciousness, we diverge to explore multiple theory foundations. The result is that we do not develop beyond the foundations. The rest of the scientific community, seeing us constantly re-inventing our foundations, yawn and if interested at all, make a note to check back at some future date to see if we have gotten anywhere. We must get somewhere. And so we must agree to agree, at least long enough to be convinced or unconvinced of certain views. I am therefore proposing that the foundational concepts presented here are suitable for such agreement for working purposes, and that a group of interested scientists should gather together to develop this science, along with educational curricula. From my own work, it is clear to me that the fruits of such study will be great in cosmology, ecology, informatics, philosophy and ethics. There may hardly be a field of human inquiry that is not touched by clarifying this shift in perception.

THE BASIC RELATION

I have shown elsewhere that Rosen’s “modelling relation” is both a meta-model for epistemology (it describes science) and an ontology for nature (it describes origination) in relational theory. Both relations are reproduced in Figure 1. I have also shown that this relation is infinitely constructible, both holarchically and laterally, thus allowing it to be proposed as a fundamental structure of reality.

By objectifying the basic relationship between actual and potential existence (the modelling relation), a clear mathematical foundation for non-dualism is obtained. This view is revolutionary. Accordingly it is controversial among Western trained scientists, for the simple reason that we have wished to explain all of nature in terms of mechanisms alone. However, it is surprisingly congruent with ancient Eastern philosophy and science (Kineman and Kumar 2007). The Upanishads of India, for example, describe the ultimate reality as just such a relationship. The Taittiriya and Mandukya Upanishads, for example, describe existence (in Sanskrit, sat) and awareness (chit) as a single reality or one-ness, the true experience of which is bliss (ananda). The Chandogya Upanishad similarly describes the ultimate reality as existence (sat) and non-existence (ti) yoked or bound together (yam). The Sanskrit word Satyam thus means the ultimate and complete reality, which is Truth. Hence, in ancient wisdom, it is the combination of two logical opposites that constitutes a creative relation and is the origin of all existence. (Muller 1884).

The relational view is definitive, therefore, in its acceptance of material existence describable as mechanism, in relationship with its logical opposite, which is the pure absence of mechanism. By taking the relationship itself to be the reality, we can then explain complex phenomena, where a system will appear to any outside observer as exhibiting unpredictable or uncertain behaviour. This occurs naturally, as a consequence of the relationship between material existence (represented in sat) and perception of that existence (represented in chit), that relationship defining the essence of connection and interaction. That relationship can be imagined as the ‘awareness’ of each material system of another, which then underlies our scientific concept of interaction.
The modelling relation identifies the most basic duality underlying all other dualisms: that between observer and observed. This duality is well known in all fields of academic inquiry. Development of relational theory based on such complementarity is directed toward comprehension of the non-dual in terms of information relations that represent the properties of wholeness. In other words, we rip the fabric of reality by observing it (and ourselves), creating dualistic perception and thereby departing from both experience and knowledge of the natural unity (the Biblical fall from grace in the Garden of Eden). We then seek to recover that knowledge through information relations, and we seek to recover that natural feeling through the experience of relationships. In this way, the root of relational theory is rather obvious and intuitive to many people today, there being endless descriptions of it in popular and traditional literature. But there has not been a coherent scientific theory of this relation that can bring a practical common understanding until now.

As science, this approach of course remains intellectual, but it can nevertheless share ideas in the quest for ultimate, experienced knowledge, which in Vedanta is referred to as jnana (true knowledge, or wisdom), or the path of jnana yoga (joining with or through jnana). In Vedanta, and most other deep philosophical inquiries, our worldly perception is recognized as dualistic (dvaitic); whereas the knowledge and experience one aspires to for knowledge, peace and happiness is non-dualistic (advaitic). ‘One-ness’ in Christianity is a similar idea.

Such relations that extend across the subject-object boundary (both sides of which may be present as perception, and also dissolved in action) must be treated as creative (i.e., ontological) information relations. Rosen identified these relations as ‘encoding’ and ‘decoding.’ As such, they account for a continuum of natural systems and behaviours from matter to organism, and they may be taken as defining the most essential and fundamental aspect of mind in nature; an idea that accordingly must regain modern currency.

**THE ONTOLOGICAL DOMAIN: CAUSAL ISOLATION**

Rosen’s very thorough development of the mathematical and philosophical foundation for relational theory thus allows a new science to be articulated that is compatible with both
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Western and Eastern thought, and that vastly improves our ability to understand complex phenomena.

In simple language the idea of relational theory is to describe nature in terms of material systems that represent (model) each other and that are themselves expressions of such models. The result of this approach is to relax the mechanistic constraints on what we think nature can do. Less constrained systems in nature may then exhibit self and universally creative phenomena because of causal loops (self-entailments, or “impredicativities”) that are not otherwise allowed in mechanism. These are information feedback loops that are considered to be responsible for all behaviour and complexity, generating system dynamics and structure. When fully constrained, or reduced to equivalence between model and system, these relations account for classical existence and behaviour. That has been the primary subject of Western science for centuries. When unconstrained, i.e., unreduced, they account for complex existence and behaviour, which is now obvious in quantum, cosmological, and dissipative systems phenomena (such as whirlpools or other energy vortices). In a sense, these systems ‘buy’ various forms of self-causation by dissipating energy. When they are more organized, unconstrained modelling relations may then account for living systems and their phenomena. This hierarchy of system types explains why mechanism and reductionism have become a problem in modern physics, and why they have been such a bane in life and social science; while at the same time they have been a necessity. Both constrained and unconstrained relations are involved in nature. We can no more propose that nature is comprised solely of unconstrained relations than we were able to get away with the idea that it is comprised of only constrained relations. Everything interesting about existence has to do with crossing this threshold (or in some spiritual ideals, transcending it).

The key to the formation of such complementarities, or causal loops in nature, ranging from the constrained to the unconstrained, is the existence of a causal boundary; i.e., some form of causal isolation. Because this is a view in which nature is essentially self-causing, as systems distinguish themselves and separate their causes must go with them. Causation thus becomes at least partially isolated. The collective properties of nature that might be ascribed to general and universal laws, properties of common causation, require interaction and are the properties of interaction; they arise in a system, or for that aspect of a system, that is interactive. It is also clear that to the extent that interaction is delayed temporally or separated spatially, causation itself becomes more independent of the larger system (of interaction or observation). In that case, the ‘absolute laws’ of nature, i.e., the commonly shared laws, no longer explain the behaviour of separately defined parts. Those parts (or more properly, ‘components’) have internalized the very same laws and perhaps additional ones.

Two material states or systems thus interacting should exhibit complexity when their isolation is apparent against a background of collective definition, where isolation is not apparent. In other words, the difference between self definition of states of a system, and the definitions imposed by other systems externally, becomes apparent with some form of system isolation. Two kinds of physical isolation that are now well-known, are quantum and relativistic. These correspond to isolation in time and space, respectively. In both cases, we see natural complexity exhibited; in quantum behaviour and in relativity (Kineman 2000). However, as in the theory of quantum decoherence on the one hand, or the formation of relativistic matter (from the big bang) on the other, classical systems emerge from numerous and rapid interactions, where the interactive properties of the collective background overwhelm the properties of isolated system interaction and thus dominate the results of additional measurement. This is a very simple theory that accounts for the fact that at
classical scales, and in the absence of any other form of causal closure, quantum and relativistic behaviours become insignificant and material properties therefore appear classically mechanistic.

**THE EPISTEMOLOGICAL DOMAIN**

While the ontological domain of relational theory is modelling relations (Figure 1), the epistemological domain is information itself, described by Rosen as “encoding” and “decoding” relations. These relations are entirely contextual (existing in the “ambiace” of any modelling relation) and thus analysis in these terms is both hierarchical among nested systems, and lateral among related systems. The result is representation of a natural holarchy, where indeed “everything is connected to everything else;” as the popular saying goes, but in ways we can now understand through relational analysis.

The mathematical domain for description in this science is *category theory* (Louie 1985; Louie 1985). Category theory deals with the causal mappings of one entity into another according to various functions that govern the transformation. Modelling relations, which form the foundation of relational thinking, can be translated into the highly graphical language of category mathematics. A typical expression in this mode might be, for example: \( f: A \rightarrow B \), which means the function, \( f \), governs the transition from a set of conditions A to a set of conditions B. In relational theory, these entities, A, B, etc., can themselves be functions, thus allowing various kinds of causal feedback to develop. The relationship of this analysis to the ontology presented as modelling relations is clear, because function can be associated with decoding and structure can be associated with encoding. The result is thus some appropriate form of structure-function analysis (Kineman 2007b).

Classical nature (congruent with mechanistic analysis) can be shown to emerge from this kind of complexity, not as the fundamental reality (i.e., material “building blocks” of nature), but as a shared and constructed condition of complex system interactions in which a mechanistic background must form from collective interaction. We thus find a classical scale in nature where complexity, owing to the spatial and temporal isolation of material events, becomes insignificant compared to the common frame of reference these events collectively produce. To whatever extent causal boundaries are thus absent, interaction thus defines a shared measurement (or state) space in which the creative modelling relation appears reduced (fully commuting between model and its realization).

Aside from the physical cases of isolation that exist at the limits of physical and perceptual scale or in dissipative systems, there is another kind of causal isolation that may have developed from dissipative systems, that is found in organisms. While all recognized living systems are dissipative systems, organisms do more by employing complexity to build life strategies. This kind of causal isolation can be described as holistic, because it rests on the development of identity, where an internal system definition distinguishes it and causally isolates it (in part) from its context, or environment. This kind of isolation is an actual causal ‘closure’ of the system. Figure 2 reproduces Rosen’s fundamental closure diagram for the case of organisms, which is a minimum requirement for their definition.

Organisms capture and express the complexity of modelling relations by a higher level of system organization than that of an inorganic dissipative system. They close “efficient” and higher Aristotelian causes within the organism to produce metabolic (M) and repair (R) functions. Repair includes reproduction. Such living organization can be described as
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comprising internal system models that account for the system-specific functions. Collectively, these internal entailments confer identity, which then may or may not be cognized depending on the degree of cognitive function.

From this basic theory of complexity, where all interactions are considered in some way primitive ‘models’, it is not hard to imagine conditions under which this more developed kind of internal system model might form. All the archetypical ingredients for life exist in relationally complex systems, and their ‘emergence’ from physically complex systems is a matter of hitting upon a loop causal structure that serves to acquire energy (metabolism) and to produce a second function that serves to maintain the first (repair). From that organization alone, evolution can maintain these basic functions and add more, including the cognitive components that we observe. Evolution, in this view, would clearly be driven by both passive and active selection. Active selection from learning and decision making, as James Baldwin proposed (Baldwin 1896), is a logical consequence of internal modelling relations (Kineman and Kineman 1999; Kineman 2002). It is also not hard to imagine, and in fact it is axiomatic in this view, that aspects of life as we experience it in our human form, exist, albeit in primitive form, in all of nature.

Analysis of complex systems can be performed by relating structure and function, which are the epistemological units of the modelling relation. Figure 2, in fact, can be broken down into seven modelling relations that close internally except for structural and functional presence in the environment (Figure 3). Reproduction and repair entail the organism structurally with its environment as a defined material system (defined by its genetic code and its phenotypic pattern of material organization). Metabolism entails the organism with its environment through behaviour. The organism thus participates functionally and structurally in its outer surroundings, which subjects the organism to the processes of adaptation and evolution.

By recognizing the way that structure-function epistemology obtains from the ontology of modelling relations, the original system complexity can be reflected in a relational system analysis. Generally, this involves representing realized and potential structure-function relations in the organism and its context (Banathy 1999; Kineman, Banathy, and Rosen 2007).

Figure 2: Efficient causal closure (self-entailment). Dashed red line indicates functional expression (decoding), solid line indicates system structural change (encoding). $f =$ metabolism, =$ =$ repair/reproduction.
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Figure 3: Efficient causal closure in terms of Structure-Function relations.

BASIC PRINCIPLES

The modelling relation considered as a natural unity thus explains the origin and complex nature of both the living and non-living world. Although revolutionary and controversial, it provides a unique and scientifically world view in which a theoretical synthesis can be achieved between the mechanical and the complex. Some basic tenants of this synthesis are:

1. Nature is best imagined in terms of interconnected and holarchical relationships between explicit forms (realized material systems) and implicit forms (the contents of natural models).

2. The explicit form is an observable (measurable or classifiable) material existence that might otherwise be described in terms of energy and matter (but not limited to those concepts).

3. The implicit form is the reflection or specification of an explicit form. The implicit form (analogous to a 'formal system' in mathematics) may be thought to exist in "the organization" of a directly or contextually related system. It is an aspect of a natural, material system, and is thus part of nature.

4. The relationship between explicit and implicit forms is a "modelling relation" as described by Robert Rosen. This relation defines natural complexity. The explicit and implicit forms, when recognized in this relation, account for all that we can know or infer symbolically of the natural world. Modelling relations can thus be taken as the fundamental theoretical units of analysis of nature at all scales and all systems.

5. Modelling relations are information relations in the sense that each related system 'encodes' to or 'decodes' from one system's organization to the other's. In this precise way, systems can be said to 'interact' (i.e., to act together and between each other). In the general case, encodings and decodings are not exact and thus do not fully commute. They are comprised of abstracted patterns (from observation or interaction). Abstraction is thus a feature of the natural world, and material (measurable) states are its result.

6. The obvious presence and predictable persistence of a general mechanical (classical) world of observable states, arises from the collective effect of multiple (complex) modelling
relations, to the extent that their interactions are not isolated from the general system of interactions. The classical world that is generally given to mechanistic description is thus a special, reduced case of general relational complexity where explicit and implicit forms (a system and its implicit 'model') are sufficiently constrained that they are essentially equivalent, and causality is sufficiently general that behaviour can be described precisely. Nevertheless, complex relationship remains latent.

7. Organisms represent a different case of relational complexity, where modelling relations have themselves been internalized. Such internalization closes efficient causation. Functional relations combine to produce self-entailed organization. The minimum functions required are metabolism and repair (which includes reproduction). Metabolism and repair functions, in turn, entail the organism with its environment.

8. By internalizing modelling relations themselves, organisms thus develop sophisticated models that allow them to adapt to persistent conditions in anticipatory ways. By innovating, they can actively drive their own evolution in a Baldwinian sense, especially to the extent that such models may be said to involve cognition, choice and will.

**CONCLUSION**

Modelling relations, as the presumed 'reality' of nature and appropriate basis for analyzing its complexity, are thus to be considered ontological entities. They are assumed components of living nature in that they comprise a fundamental way of thinking about nature. As such, this view of nature is more general than the mechanistic view, underlying classical, complex, and living systems. Modelling relations are capable of representing the origin of natural systems and their laws: they provide a conceptual bridge across traditional duality, without compromising known science on the one hand (e.g., of mechanisms) and obvious unexplained phenomena on the other (e.g., of complex and living systems). Relational theory is capable of dealing with systems that originate themselves and their own behaviour. The modelling relation translates directly to epistemological and empirical elements, which are the modelling relation's 'encodings' and 'decodings,' corresponding respectively to 'structure' and 'function.'

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ABSTRACT

Abstract. The combined “inness” and “outness” of our sense experience, such as seeing and looking and hearing and listening, has been systematically investigated from the physical input, psychic output and combined perspectives. For completeness, both the Seer and Attention were included in the proposed analogies for perception. Phenomena rationalized by the combined analogies included interruption of the physical chain of events, coherence of and location of images, separate seeing of the eyes, and stability of the viewed world. Also the dual physical and psychic nature of our senses was verified by examples of distant looking and listening. We structured our knowledge of the senses by an Absolute Theory of Attention from the Vedic tradition. Connections of sense experience with the Divine were made with spiritual traditions worldwide. Including the subjective aspects of Attention and Seer in the combined analogy does not interfere with normal ways of gaining reliable knowledge.

Keywords: Attention; Being; integrated perspective; seer-seeing-seen; senses; Vedic Science.

INTRODUCTION

Have you ever wondered about your sense experience? A remarkable feature about it is its “out-thereness” (Harris, p. 313). When we look at something, we see it “out there,” even though our sensory apparatus, our eyes and nervous system, is “in here.” Likewise, when we touch something, our sensation of it is at the point of contact of our hand, say, and the object of touch, the tabletop, for example. Once again the sensation does not occur along any nerve passage or in the brain, but at the point of touch. Lastly, consider the sound sense. The music from the radio comes from “out there” even though the compression waves are carried through the air into our ears and brain “in-here.” Figure 1 shows “Inness” and “Outness” in graphic form.
"Inness" and "Outness" of experience is something we have lived with all our lives, but how many of us have ever really stopped to consider how extraordinary is its ordinariness? How can sound come from your mouth when the sound waves from your voice box travel to my ears? Could it be possible that the "me" that is doing hearing "in here" and the "me" that is doing the listening "out there" is the same me? This and other questions will be considered in this paper.

Historically, the question of "Outness" and "Inness" of sense experience has been the subject of much discourse (Lindberg 1981, Machamer and Turnbull 1978, p. 137-160). Discussion has taken scientific, spiritual and philosophical forms. In this paper we will follow the scientific form as much as possible. This means that there will be more emphasis on experience than on logic. As needed we will refer to other traditions of knowledge, namely metaphysics, which in an elementary sense is just drawing pictures (Ong, 1988) (Schroedinger, 1956) and Vedic Science from spiritual traditions (Maharishi Mahesh Yogi, 1987). Vedic Science is the science of Being and the empirical dimension of this science is the experience of Being. Thus the three major fields of knowledge that we will use, Science, Metaphysics and Vedic Science all have an empirical basis.

The goals of science are to obtain structured knowledge, which is repeatable and verifiable. This will be our goal also. The scientist also works from an analogy, often implicit. We will attempt to make our analogies explicit; further, it is not possible for any
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analogies to be scientifically correct in a literal sense since the map is not the territory. We can only disestablish the validity of any proposed theory or analogy by falsification. The substitute analogy is then subject to acceptance or rejection according to its success in accounting for the empirical facts. In this paper we will not establish the truth of anything; the best that we will be able to do will be to falsify a proposed truth or demonstrate its incompleteness.

To analyze sense experience, we will first use an “inness” model, then an “outness” model and finally a combined model. The combined model, a synthesis of the two, will include the perceiving Self (that which says "I") as part of the model. It will also add a psychic or spiritual dimension to the senses, so that the senses will be shown to be more than the physico-chemical response of the corresponding stimulus. We will use the science of the experiencer, Vedic Science, to add structure and understanding to the analysis. As Schroedinger (1956) has pointed out, a peculiar feature of science has been its predisposition to exclude the experiencing Self from its world picture. You and I are completely missing from the scene! By including the Self, which we will attempt to do, we can allow for the influence of the Self on the process of seeing in our analogy. We will find, not surprisingly, that its influence on the process of seeing is considerable. We will also show that objectivity, in any sense, is impossible.

DEVELOPMENT

An understanding of how we see has been sought since antiquity, and an extensive literature exists on the subject. Two schools of thought have dominated discourse: first, the “Inness” of experience school, and second, the “Outness” of experience school. Intromission, relates to the inward direction of stimulus from the outside into the sensory apparatus of the viewer. Conversely, Extramission, relates to the outward visual stimulus from the viewer to the viewed object. Let us begin our inquiries into the understanding of the sensory process by a consideration of intromission.

Intromission

Figure 2 supplies an analogy of the intromission process along with a verbal description (Siegel, 1970). This is the familiar “objective” analogy used in science: materialistic and deterministic. Material input, energy or matter, causes material output, energy or matter. We can test the model for ourselves by following the path of the stimulus described in the figure. Light from the object viewed enters the sensory apparatus of the viewer and causes stimuli on the retina, in the optic nerve and ultimately in the brain. All of this “causes” us to see, Step 5 of Figure2. Sight will be impaired if the path is interrupted for any reason: lack of light, damage to the eye or the optic nerve, or brain damage. The model seems plausible so far. Let us now use the analogy as a basis for asking questions. First if an image is formed, such as the one depicted in Figure 2, following step 4, where is it located? Second, since all this neurological activity causes us to see something,

3
Where is the seer of the image, where are we? Turning to the first of these questions, we note from experiments with binocular vision that the geographic locus of either the one-eyed or binocular image has not yet been found. A simple experiment in binocular vision can help us here. By crossing our eyes, either voluntarily or involuntarily, we see two separate images. If we now uncross our eyes, the two separate images again cohere. Question: where does this coherence occur? No screen has been discovered at the back of the head where the two images could cohere. There is nothing between the two halves
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of the brain where the same coherence could occur. No master awareness cell in the brain has yet been discovered. Further, flicker experiments (Sherrington, 1963) suggest that such integration of images is not physical, but psychic: the image is out of the bounds of time and space.

In addition, if we first close one eye and then the other, the light intensity of the world remains essentially the same whether one or the other or both eyes are open. We can now reason that if our sight were completely physical we could expect that since half the intensity of light entered our sensory apparatus when one eye was closed, we would sense approximately half the intensity of what we viewed when both eyes were open (Sherrington, 1963). This does not occur. Accordingly, we reason that seeing is not a completely physical process. Further, this conclusion is not inconsistent regarding the “whereness” of the coherence of the binocular images discussed above. In both experiments it has not been possible to physically locate the image, which we would expect to do if it were a purely physical process.

We ask: where or who is the seer of the image? Consider what Gregory (1978, p. 48) has to say concerning the image of the object, Figure 2. “We do have mental pictures, but this should not suggest that there are corresponding electrical pictures in the brain, for things can be represented by symbols—but symbols will generally be very different from the things represented.” So far so good, he seems to be in agreement with the earlier conclusion regarding the inability of the image to be spatially and materially located. He then goes on: “The notion of brain pictures is conceptually dangerous (emphasis added.) It is apt to suggest that these supposed brain pictures are themselves seen with a kind of inner eye involving another picture, and another eye…. and so on.”

Clearly he recognizes the limits of the intromission model but appears to be unwilling to take the step out of the objective-material model into uncharted territory. However, there is nothing that says that we have to be so constrained. Models not only have analytical and explanatory power but also have heuristic value; that is, they help us to ask questions of our analogy. So using Figure 3 as an aid, we ask who is the someone that seems to be looking at something or through something. From our own experience, we see something when we look “out” from our eyes. Also, rather than dismissing the infinite number of internal eyes as an impossibility as Gregory proposes, consider perhaps that what is looking is infinite in nature, Figure 3a, an unbounded field, perhaps. The incorporation of an unbounded seer into our model is not particularly satisfactory from a material perspective. However, certain facts of existence (non-localizability of both the image and the seer) oblige us to consider this possibility seriously. In anticipation of further development and to supply some theoretical understanding of Being, we draw on Vedic Science.
What is looking is an aspect of a yet deeper entity, Being or Self, Figure 3b. You can think of Being or the Self as the “I” which says, “I see.” Being, although possessing no attributes, can be thought of as an infinite field with the “I” and the “see” displaying infinite qualities. Your “I” is part of the field you move around in, and since the field is infinite, contact with your “I” is never lost. Symbolically in Figure 3b, we represent unmanifest Being as a straight line differentiating into unmanifest Knower, Knowing and Known, which we then experience as manifest Seer, Seeing and Seen. For a scientific
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discussion of how this field of Being can coexist with the knower, process of knowing and known in infinite correlation with material existence, see Bentov (1977, Chapter 3). Empirically, our experience is “I see the object of experience.”

We have begun the process of incorporating the knower into our understanding of the nature of seeing. Perhaps we can now appreciate the difficulty experienced by Professor Gregory (1978, p.48) in his encounter with unbounded Being. There simply has not, up to now, been an adequate Science of Being with which to develop understanding. This, of course, has been recognized by others, among them Schroedinger (1956, p.209).

As our conception of the process of seeing is expanded, we will accordingly develop our understanding of Being. Briefly summarizing so far, a material intromission model works for some physical aspects of sight (absence of light, damage to the apparatus, etc.) but fails significantly with respect to other phenomena (separate seeing of the eyes, location of cohered binocular vision, etc.). We can conclude accordingly, not that the intromission model is incorrect, but that it is incomplete. We have begun the process of making our analogy more complete by adding to it the seer of whatever is being seen. There now remains the task of relating the seer to the seen (through seeing) and to rationalize the “Outness” of our experience. This is the subject of the following section.

Extramission

In the extramission analogy, the direction of vision is directed outward from the viewer to the object of perception. Figure 4 depicts the process. Temporarily, I have employed terminology used in antiquity by Plato, Euclid and Empedocles among others to signify this outward emanation: fire, particles, rays, etc. (Park 1999, p. 35-41.). A modern objection to extramission is that once the signal (fire, particles, rays, etc.) leaves the Seer, all communication with the signal by the Seer has been lost, so that the Seer would not know what was being looked at. Conversely, however, in support of this analogy is the fact of subjective experience that we all have of the “Outness” of the object of perception.3

Let us try to rephrase the older terms for the extramitting emanations (fire, arrows, particles, etc.) into modern terminology. How about attention? When we put our attention on an object “out there,” note that we do not lose contact with attention as it flows outward from the seer to the object viewed and back again.4 To account for the fact that contact is not lost between Seer and object seen, we use the concept of the infinite eye as a field of awareness, Figure 5.
The behavior of attention becomes more intelligible when we treat the infinite eye as a field, very much analogous to a gravitational or an electromagnetic field. Fields act at a distance and interact with the objects within them, with the objects in the field exhibiting mutual interaction. Like that, Seer and seen interact mutually, at a distance, by means of attention.

Briefly summarizing to this point: when we try to account for “Inness” and “Outness” of experience by two familiar analogies, intromission and extramission, we encounter the necessity to include the Seer as a field. Furthermore, upon analysis we find the Seer impossible to localize. The “eye” icon in Figures 3 and 5 represents this graphically. Further, if we did not include the Seer, the model would be incomplete.
We have analyzed two models of perception to help us understand both “Inness” and “Outness” of experience. Each analogy has explanatory power as well as limitations: Intromission is a physical analogy, while Extramission is non-physical. We can combine the two for a more complete analogy. This combined model will provide opportunity for further insights as well as for inquiry and speculation. Figure 6 shows the Intromission and Extramission analogies of Figures 2 and 4 combined.
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![Diagram of Intromission (Seeing) and Extramission (Looking)]

**Figure 6.** Intromission and Extramission Models Combined.

Figure shows Looking (Extramission) and Seeing (Intromission) as well as the Image of the (seen) Object in the psychic space of the Seer.

Note that this combined model agrees with our everyday understanding of looking, which is subjective, outer directed and psychic, and seeing, which is objective, inner directed and physical. The model also contains the infinite field of Being (the eye icon) which we need to maintain “attention at a distance.” The combined model also contains the image of the object, as shown in Figure 2. However, recall that in our consideration of the image, no location has been found for it so far, and it has been shown in Figure 2 as occupying “psychic” or non-physical space. Regarding the image: just where is it? To make matters no more complicated than necessary then, let the image and the object directly coincide as shown in Figure 7.
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By this action the psychic image has been removed as unnecessary. There is no psychic image of the viewed object. Our perception of our outer world is immediate. This should make empirical sense to us. After all, when we see something, we don’t register a picture of it and then look at it. Likewise when we hear a voice, we don’t record it someplace and then listen to it. The sound we hear also is immediate. To help us structure our understanding of perception let us draw on an Absolute Theory of Attention (ATA) from Vedic Science6 (Maharishi, 1976). Parenthetical comments, which accompany the theory, are intended to help relate the theory to our models.

1. “Attention is the flow of consciousness. It flows both within its own unmanifest nature and outwards towards greater levels of excitation.” (Refer to Figure 3b and Figure 7 for a schematic representation of this step.)

2. “In the process of perceiving objects, attention flows from unmanifest to manifest. It enlivens both subject and object, perceiver and perceived.” (Unmanifest Being underlies everything as schematically represented by the solid line in Figure 3b, and by the eye icon in Figure 7.)

Figure 7. Combined Model.

The object of perception and the image of the object, heretofore located in the psychic space of the Seer (Observer) have been made coincident. The Field of Pure Being (Eye icon) is shown, as is Attention (block two-way arrow) which is differentiated into two parts: Looking out and Seeing in.
3. i) “Attention is the link between subject and object.” (Note two-way arrow in Figure 7.)

3 ii) “When it goes towards objects, consciousness takes on the form of the object.” (This step results in the “outness” experience of looking, Point A, listening, Point B, and feeling, point C of Figure 1.)

3 iii) “Attention identifies an object by transplanting it onto the consciousness of the subject.” (If this were not so, there would only be vibrating particles in a dark universe. It is the Self that supplies to the world the rest: color, shape, brightness and all other attributes. The Seer is the “greatest of all cosmic wonders” (C. G. Jung in Schrödinger, 1956, p. 216).

Statement 3 iii) will present conceptual difficulty for some because the consciousness of the subject appears to be where the object is, but at the same time it is “I” that sees through the eyes of the subject to the object “out there.” How can this troublesome paradox be resolved? Elsewhere it has been suggested that such resolution can be achieved by expansion of our frame of reference (Ong 1988, p. IV-8, Russell 1974, p. 26). In this case it suggests that the self, the Seer, is everywhere present as a field, Figure 7. This is consistent with the initial observation of “Outness” and the evidence presented so far for consciousness to be a field phenomenon. I (in here) see “out there,” I (in here) hear “out there,” I (in here) touch “out there.” The Seer is both material and spiritual, temporal and eternal, bound and free, finite and limitless.

Returning now to the question posed in the introduction: am I part of everything I see? From Figure 7, we infer that I am indeed everywhere, and that there is no limit to the Self.

We can expand on our synthesis. Figure 8 depicts the attention of our analogy to be both physical and psychic; the physical part, seeing, exists within time, space and causation, and the psychic part, looking, exists out of the bounds of the physical. The psyche consists of ego, mind, emotion, intellect and senses. In turn, at least a part of the senses, consisting of hearing, sight, taste, touch and smell have their origin in the field of Being (Maharishi1994, p. 62). Using Figure 8 as a way of asking questions, our model would seem to indicate that our senses are part physical and part psychic. Can we put this to the test? We can, in a number of ways. Consider first, the sound sense. A listener, Figure 9, hears a distant sound in the form of a thunderclap.
How to Look Across the Room

Figure 8. Combined Analogy Expanded.

The illustration differentiates the physical (passive seeing) and psychic (active looking) aspects of perception and also elaborates the multi-dimensionality of both physical and psychic realms.
Depicted is the occurrence of a thunderclap occurring at point A about one mile from the listener, point B. We know from the lightning flash and its speed of travel and from our knowledge of the speed of sound in air, about one mile in five seconds, that the sound wave takes about five seconds to reach our ears. At the instant of its arrival, our experience is of a sound occurring immediately at the origin of the sound. We conclude that our sound sense is indeed of two natures: a) physical, requiring a finite amount of time to register and b) psychic, requiring no time to register.

Consider in the first sight case, the occurrence of a supernova event at a distance, d light-years from the observer, shown in Figure 10.
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The light waves reach our sensory apparatus after $d$ years. We see it after a finite amount of time. However, our apprehension of the supernova event occurs immediately. Again we can conclude that our sight sense, like our sound sense, is of two natures, physical and psychic.

The second case demonstrating the dual nature of our sight sense is the viewing of a mirror image. Figure 11 demonstrates this phenomenon.

The incoming light rays reflect off the mirror surface into the sensory apparatus of the seer, producing a laterally inverted upright virtual image of the object “on” or “behind” the reflecting surface. Concerning the production of the image, Intromission theory has little to say. However, from the expanded perspective of the combined In-Out model, we note that the incoming stimulus, light waves, is physical; and the outgoing effect, flow of attention, is psychic. This is consistent with Step 3 iii of the Absolute Theory of Attention (ATA). From this example we also can infer that attention of the seer apparently “flows” in a straight line. This is also consistent with our experience.
For many, accustomed to thinking in physical terms, the idea of the outness of our experience will be difficult to get used to. However, recall that images exist in psychic space, not physical space. Also, from the Theory of Relativity, we know that at the speed of light, both space and time shrink to nothing, so from the frame of reference of a photon traveling at that speed time and space do not exist. In analogous fashion, instantaneous sensory apprehension, transcending space and time, should not appear out of the ordinary, especially since that portion of our senses is non-material, or psychic. Thus, from both a material and psychic perspective, immediacy of perception is plausible.

Another objection that could be made lies in the use of the combined In-Out model, Figure 7. If we were to revert to the physical Intromission model, Figure 2, we could do away with all this instantaneous seeing of things many light years away. Yes, but…the image still exists in psychic space, not physically locatable.

Yet another difficulty for many will be the miraculousness of the outer-directed looking and listening of the combined model. But miraculousness cannot be avoided. For example, in the intromission model Step 5 of Figure 2, “the experience of sight” is

**Figure 11.** Viewing Mirror Image.

Physical light rays from object reflect off mirror into sensory apparatus of Seer. Seer projects attention onto mirror to produce laterally inverted virtual image. Light rays are bent, but flow of attention is in a straight line.
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another example of it. Once again, from a material perspective the choice appears to be between two undesirable alternatives.

The last word has not been said on this subject, but as Harman (1969) has noted, this represents a situation calling for responsible dialog for its possible resolution. We would add the provision, however, that if an alternative analogy is to be offered as a substitute candidate, its nature should be made explicit.

Another phenomenon that can be cited to make a case for both types of perception, relates to the question: Why does the world remain stable when we move our eyes (Gregory (1978) p. 101)? Our eyes are continually in motion, making tens of thousands of movements each day. These motions are called saccades. At each move there will be an image on the retina at a different location. Yet, for all this movement, the seen background remains remarkably stable. Conversely, if the eye is moved by ones finger (lightly!) the image is violently unstable—try it for yourself.

In the first case, the perception is active like the projector or extramission model, Figure 4. In the second case, the eye is behaving very much like the camera or passive intromission model, Figure 2. If these saccades are not extramission, they certainly are not intromission! What a dramatic contrast in behaviors!8

Consider the saccades again with the eyes making their many daily movements. For every movement we make, we see a new image immediately, with no lag in image formation. Further, the retina, despite the large number of new images it adapts to, does not seem to get tired. Once again the data supports a non-physical extramission process involved in the phenomenon of seeing.9

We have put together a combined model to account for inness and outness of seeing. The model includes Seer, seeing and seen, underlain by a field of Being. Evidence has been put forward to disestablish Intromission as a complete model to describe Outness of experience. This includes non-localized images, single- and double-eye opening, absence of a Seer, absence of attention, absence of a psychic dimension to the senses, empirical evidence of our dual sensory nature and the instability of sensory input when the eye is passively moved.

In the next section we will expand on the usefulness of the combined model and indicate some possible further applications for it.

DISCUSSION

We now consider some possible applications of the combined model, which include considerations of completeness, objectivity, state of Being of the Seer, flexibility of thought, connection of science with spiritual tradition and scientific implications associated with the adoption of a new analogy.
How to Look Across the Room

Completeness. We have added “looking out” and the Seer to the “seeing in” model, with some success toward making our analogy complete. Is our analogy complete? Consider the situation shown in Figure 2 where we see that an inverted image on the retina gives rise to an upright representation of the object—a mystery (Park, p. 303)! Also consider the formation of a laterally inverted image from a mirror reflection\(^0\)...another mystery (Gregory (1997) pp. 88-103)! We conclude that the proposed analogy is incomplete in respect to supplying an explanation for these phenomena and in other respects.

Objectivity. Refer to Figure 8 to follow the path taken which results in the occurrence of sight. On the input (physical) side, the path (of light) taken follows that shown in Figure 2, which is unique to each individual’s nervous system – unique eyes, unique brain. On the output side, the psychic “path” (of attention) is affected by the senses, the discriminator (where we put the attention), the intellect (our education and conditioning), the emotions (our mood) and the ego (our archetypical nature). If objectivity means freedom from the influence of the Seer, surely we can see that this is impossible. There is no such thing as objectivity as any trial lawyer or officer of the law can attest to. At the same time for many of us trained in the scientific tradition, there is a strong sense (albeit subjective!) of objective reality in what is perceived. I see (hear, feel) the real cat (table, flower, etc.) The sense of objectivity is a common reality due to agreement with other Seers, the Lockean Community of Churchman (1971, p. 95) and the “shared verifiability” of Dember and Warm (1990, p. 26). Another way of understanding our strong sense of objectivity is that the Seer imposes stability on the object. This is described in Step 3 ii of the Absolute Theory of Attention (ATA.) Nature designed our senses to comprehend our physical world clearly (objectively) for survival if nothing else.

Another reason to consider that the Seer is responsible for our sense of objectivity is our sharpness of vision. The eyes are capable of detecting minutiae in our field of vision (a leaf on a distant tree, an insect on a branch, a pebble in the grass, etc.). Surely we can infer validly that it is the Seer, not only the one “in here” looking but also the spotter, the “I” that is “out there” that picks out the details in a scene. This is another example of seer manifesting as both seer and seen, Step 3iii) of the ATA.

State of Being of the Seer. In addition to the physical state and the psychic state of the Seer as discussed above, we should also consider the spiritual state (State of Being) of the Seer as it affects the process of seeing. It is possible through transformational practice, such as meditation or prayer, to infuse the Seer with greater amounts of Pure Being. In so doing the Seer becomes more “awake,” “intelligent,” “aware,” or “integrated” in his/her outlook. An attempt to show this in schematic form is given in Figure 12, which shows that what is seen, either profane or sacred, is a function of the state of being of the Seer, either disintegrated personhood or integrated personhood.
In practice there are gradations of integration and various scales and states of integration have been proposed for their rationalization. Some have been described elsewhere (Hawkins, 1995, Campbell, 1974). Such extensions of the model involving the influence of Being would not be possible from the Intromission model alone. Some purposes that such an extended analogy might serve would be to rationalize mental powers, such as imagination, visualization, creativity, “remote viewing,” and intuition. It might also be possible in the future to correlate the possession of such attributes as a function of the extent of infusion of Being into the person. This could be done by kinesiology perhaps, as suggested by Hawkins or by brain wave mapping. Another possibility would be to establish a relation between one’s state of being and one’s view of the environment (for example, as mine to be exploited, or garden to be tended) as has been suggested in Figure 12.
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While we have been able to infer by intellect the existence of Being, many people have subjectively confirmed its existence by anecdotal description of immediate experience. Here is an example: “I am dual, both limitless and limited.” With regard to our unlimited nature: “I am unbounded, eternal, omnipresent” and to our limited nature: “I am also you” (Miller, p. 84).

Flexibility of Thought The use of analogies, as employed in this paper, particularly in graphic form allows for great freedom of thought as enumerated below:

Description (e.g. Figure 2).
Analysis (as done in Figures 9, 10 and 11).
Inquiry (e.g. Figure 3 concerning introduction of Being)
Connections and feedback (e.g. Figures 5 and 8 concerning attention).
Adaptability (e.g. Figures 6 and 7 concerning location of image).
Flexibility (choice of categories as situation requires).
Subsuming of paradox by inclusion of opposite qualities in graphic form (e.g. looking and seeing, matter and psyche, input and output).
Synthesis (e.g. Figures 6 and 8 concerning combining models).

Note that with the exception of the last attribute, all the others are derivative from the analogs. Analogy is basic: reason is derivative (Pirsig, p. 246).

With the introduction of Being and of the Seer in her/his physical and spiritual nature, the door is now open for extended empirical treatments of problems of long standing, such as the origin and development of humans as a species, our relation to the cosmos and our transcendent nature.

Connecting With Spiritual Traditions It has been necessary for us to add the Seer to our analogy describing seeing. Also, enlightened people from all traditions have often made connections with the Seer and the Divine. Saint Francis of Assisi said, “What we are looking for is what is looking.” Also Meister Eckhart stated, “The eye by which I see God and the eye by which God sees me is the same eye.”

We also have “Ye are the light of the world” (St. Matthew 5:14) from the Western spiritual tradition and from the Vedic tradition we have, from the Chhandogya Upanishad, “There is a light which shines beyond the world, beyond everything, beyond all, beyond the highest heaven. This is the light which shines within your heart” (Mascaro (1965) p.113.) Without the Seer, whether saint or sinner, believer or pagan, there are only vibrating particles in a dark universe. Both the scientific conclusion and the spiritual realization are congruent. From the Quran of Islam we have “God is the light of Heaven and of Earth.” If we can relate the eye of our model with the Divine, then once again we have congruence.

Importantly, we should recognize that ordinary experience is identical with divine experience. If we can see, touch or hear, we are having divine experience. The validity of this is empirical and not proscribed by ecclesiastic, written or any other authority. We should teach this to everybody!
How to Look Across the Room

**Scientific Implications.** The foregoing treatment of “outness” of experience presents the scientist with great opportunities in the following ways:

i) There is no threat to objectivity as it is presently understood: make your observations and your measurements, test your theories, draw your conclusions and establish your laws. In fact, the subject matter of both the currently in-fashion intromission analogy and the combined analogy of this paper should be as rigorously tested as any other scientific theory for agreement with experiment.

ii) With the expanded analogy, the door is now opened for fields of research heretofore considered off limits to science. The research referred to is research on the Self and its marvelous capacities. It is now time to put an end to depreciative allusion to the supposed shortcomings of the human: insignificance, subjectivity, illusion, solipsism and projection.

iii) Also, the opportunity now becomes available for us to abandon the objective, physical, determinist analogy as an exclusive model. It now becomes possible to set in rational and scientifically verifiable order, more facts of experience. These include looking, “outness,” non-physical (spiritual) reality including attention, the dual nature of our senses and the spiritual state of Being (Wisdom, Integrity, Intelligence) of the subject. Let us now close the door on the science of limitation and open the door to the science of all possibilities!

iv) It has been recently observed that science advances by one funeral at a time. Is it possible to avoid this disheartening observation? A promising start might be to examine one’s own (usually implicit) analogy, then check for contradictory data arising within that analogy and then attempt to expand it to account for any supposed contradiction. For example, expansion of one’s frame of reference has been used to resolve paradox (Russell), to include purposefulness and determinism within the same model (Ong), and to include matter and spirit within the same scientific model (This paper). Also, recognize that analogy has truth content, and that truth, not contained within an explicit analogy, is in danger of becoming baseless and irrelevant.

In summary, we have seen, in the light of the expanded analogy, that there cannot be any separation of the Seer from the process of gaining knowledge. There is also the possibility of including within the analogy not only the Seer but also including, as a variable, the spiritual state of the Seer. We have also demonstrated that by use of analogies great flexibility of thought, including inquiry, analysis and synthesis becomes possible. The connection of spiritual wisdom with scientific knowledge can now be placed on an empirical basis. Lastly, we can establish that no threat to customary ways of doing science exists from considering the expanded analogy as a more complete model of reality.
SUMMARY

We investigated the combined nature of our senses, a physical input and a psychic output, by means of two models or analogies. We started with the input model and showed that it had physical validity when the physical input was varied or interrupted, but fell short in regard to phenomena concerning coherence of images, location of images and separate seeing of the eyes. In addition it was necessary to add the unbounded Seer to make the model more complete. We added an output model and introduced Attention, a field phenomenon, to maintain contact between Seer and seen object. We then considered a combined analogy, which included physical seeing, and psychic looking. Examples of distant looking and listening were cited to verify the dual nature of our senses. To structure our understanding, we used an Absolute Theory of Attention from Vedic science that suggests that the Seer informs the world by supplying the qualities to the world from his or her state of being. The combined analogy was used to demonstrate that, from both a physical and psychic viewpoint, the Seer is inextricably involved in the process of perception. The inclusion of the Seer into the model permits connections to be made with spiritual tradition and spiritual understanding. Inclusion of the Seer into the model does not pose a threat to either objectivity or to familiar time-tested ways of gaining reliable knowledge.

CONCLUSIONS

First, whether we consider sensory experience from the extramission viewpoint or from the intromission viewpoint, in either case we must consider it amazing. We should put aside all questions of accident or pure chance. We sense by means of pure Being. We should begin by regarding each living creature as extraordinary.

Second, the dual physical and psychic nature of our senses is a matter of empirical reality, not a question of logic or belief. Whatever disagreements there might be about the theories, methods and conclusions of this paper, the fact remains of “outness” of experience that must be considered for any adequate attempt to order our experience.

Third, reason should be made subordinate to analogy. What we want to be reasonable about must be contained within an adequate model. If not, we fall into error and confusion. As the engineer Charles F. Kettering once said, “Logic is an organized way of going wrong with confidence.” Stated differently, from the east we have from Rabindranath Tagore, “Imagination [analogy formation] is an inner light which, with help of reason, leads to construction.” (Mascaro (1965) p.27)

Last, the questions of i) the “whereness” of the image, ii) the lack of boundedness of the self and iii) the apparent action of some aspects of the senses existing out of the bounds of physical limitation all point to a non-physical reality that exists in daily life that needs to be incorporated into common understanding.
How to Look Across the Room

RECOMMENDATIONS

We should adopt new working definitions of the phenomenon of perception. They should appear in reference materials and textbooks at all levels of learning, from kindergarten through college. A suggested candidate for such a definition could be the Absolute Theory of Attention (ATA) as used in this paper. In addition, graphics should be employed to flesh it out, and a summary of the major areas of understanding (and non-understanding!) that it embraces should be enumerated.

We should adopt a new model of reality, incorporating Being and Attention. The model should be consistent with both the data supporting intromission and with the data supporting extramission. There is no reason not to do this; in fact there is every reason to do so in order to uphold intellectual integrity. We can anticipate that phenomena, such as distant viewing, distant healing through prayer, and telekinesis, can now become topics of intellectual and scientific inquiry, rather than those of pejorative criticism and dismissal.

We should adopt a new attitude. The quest for knowledge should embrace the unknown and the unfamiliar, and while it is useful to limit our fields for the purposes of structuring our specific understanding, it is also good to be receptive to new fields, while preserving our critical faculties. It is not all junk science.

All knowledge is gained by a combination of miraculous physical and psychic processes. We have attempted to depict this in Figure 8. We cannot avoid this conclusion. Adopting a properly awesome attitude, we should learn to live in the wonder of it.

Postscript: Let us turn the title of this paper into a question: How do we look across the room? Answer: Pay attention. Next question: How do we look across the universe? Answer:…

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NOTES

1. Here is Maharishi’s gloss: “Vedic Science is a complete science, which extends and fulfills the objective approach of modern science by incorporating the knower and the process of knowing into the field of investigation. It provides a complete and comprehensive knowledge of the unified field of all the laws of nature [field of Being], which can be described as the unified state of the knower, known and process of knowing. Vedic Science also describes the sequential mechanics through which this three-in-one structure of the unified field gives rise to the infinite range and diversity of natural law displayed in the universe.”

2. “While [objectifying] the world we imperceptibly remove the cognizing subject from it, and…are prone to overlook this circumstance.”

3. Some people, perhaps due to inculcation into introversion ways of thought, will state that their experience of sight is “in the head.” A simple experiment that will demonstrate the experience of the “Outness” of the sound and touch senses is simply this: close the eyes and put your attention on whatever you are hearing or touching. The locus of sound and touch is certainly not in the head! We could then argue by analogy that what we see is also not in the head.

4. I used to think that “Outness” of experience was the strangest fact of existence, but now, upon further reflection I think that attention is the strangest!

5. Attempts at a synthesis of two modes of experiencing has, of course, been attempted before. For example Grosseteste in the thirteenth century (Lindberg 1981, p101) writes: “But it should be understood that the visual species [issuing from the eye] is a substance, shining and radiating like the sun, the radiation of which, when coupled with radiation from the exterior shining body, entirely completes vision.” The “visual species” of Grosseteste and our “attention” correspond to each other. In later years this synthetic view was displaced almost completely by the analytic viewpoint. This imbalance of synthetic and analytic views is beginning to soften but is still strong in places. More intractable than this schism, is the philosophical split between the Truth and the Good (Pirsig 1974, p. 371). Habit dies hard: we see it as Truth vs. Good, Rhetoric vs. Dialectic, Mind vs. Matter, instead of Truth and the Good, Rhetoric and Dialectic, Mind and Matter.

6. Veda means knowledge, of both the changing and non-changing aspects of reality. Maharishi Mahesh Yogi is in the process of reviving this knowledge and casting it into modern scientific language. See for example the Journal Vedic Science and Modern Science for many in-depth articles on Science and Consciousness.

7. This is consistent with ancient wisdom: “Existence is seeing and being-seen, or more exactly knowing and being-known, or most exactly of all, being and being-known” (Kerenyi, 1962 p.150). An attempt at a representation of this has been made in Figure 3b.
8. It is surprising that proponents of one particular view, intromission, say, will fail to consider phenomena that would contradict that viewpoint. Churchman (1971, p.70) has suggested that contradiction plays the role in western science of establishing the stopping point of formal inquiry.

9. Support for extramission also exists at the quantum level of reality. Goswami (p. 26) states: “an observer’s looking creates a unique actuality from the sprawling possibility wave—that is, conscious looking manifests the actual event from all the [paradox-free] possible ones.” It is not “Outness” or Attention that are the strangest facts of existence (Note 4), but this fact and Step 3 ii of the ATA!

10. For a discussion on the many attempts that have been made to explain the mirror-image mystery see Gregory (1997, pp.88-103).

11. The goal of Science (elucidation of law) and its ethos, material determinism, is not without irony. Laws of nature are ubiquitous, eternal, unchangeable, and omnipotent. In short, they are completely spiritual, non-physical, and transcendental. “The laws of physics…are ghosts…” Pirsig (1974, p.41).

12. A pet peeve of mine is not reporting what is not known about a subject!

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How to Look Across the Room

Measuring the Inequity of a health system: A Systems’ Perspective

Systematic Analytical Mapping Approach

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ABSTRACT

The World Health Organization in its 2000’s World Health report identified and defined stewardship as the most critical key function that must be undertaken towards a sustainable and well-performing health system. As the ultimate responsibility for the overall performance of health system lies with government, it is therefore its responsibility to take on the role of stewardship for the health system. The government should then involve all stakeholders in the implementation of this role; the ministries in charge of health should therefore take on the role of stewardship for the health care system. The stewardship role comprises the responsibility of:

- defining the vision and direction of health policy,
- developing legislation, regulations, standards, policies and directives to support the vision and the defined directions for health policy; and
- monitoring and reporting on the performance of the health system and the health of the population.

The implementation of the stewardship role will require that the equity principle that is dealt with at the operational level of decision making, be brought at the strategic level of decision making and be taken into account while defining the vision and the direction of health policy. This paper aims at providing an instrument that could be used to factor in and monitor the equity of a health system for a population group at the strategic level, through the measurement of the inequity of health system for this population group. A Strategic Equity Index, an input measure, is defined using the rate of equity of the health system, for a given population group. Applying Systems Thinking methodology, key components of a health system are identified. The Systematic Analytical Mapping approach is proposed as a methodology to be used for the identification of the challenges facing by a population group for access and accessibility to health services. The identified challenges constitute the inequity of the health system for the given population group. A formula for the calculation of the Strategic Equity Index is proposed.

Keywords: health system and health care system, inequity and equity, Systems Thinking, Systematic Analytical Mapping, Strategic Equity Index, strategic decision and operational decision, input measure.
Measuring the Inequality of a Health Care System: A Systems Perspective

Introduction

In order to ensure well-performing health system, it is recommended that governments change their role from health services providers, to take on a stewardship of their respective health system. A well-performing health system is a health system that contributes to the implementation of the health equity principle (Whitehead, 1995):

- to create equal opportunities for health for all population groups and
- to bring down health differentials to the lowest level possible.

This would mean a health care system where equity in health care is based on the fundamental principle of making high quality health care and health care services accessible to all population groups. For this to happen in a stewardship mode, there is a requirement for governments to translate the meaning of equity principle into the health system and health care system strategic decision, including integrating this into the process that guide the definition of the vision and the strategic directions of the health system and health care system. The purpose of this paper is to articulate a systematic approach to support the governments in:

- meeting this requirement and
- assessing and monitoring the equity of health system and health care system at the strategic level, towards ensuring equity both at tactical and operational level.

Inequity of health care system (uneven distribution of resources and facilities) will therefore lead to inequity in access and accessibility of health care and health care services.

A Systems Thinking methodology is chosen as the basis for the conceptual framework of this exercise. It will support the understanding of the complex processes and the inter-relationships among the subsystems or components of the health system and health care system.

Methodology

1. **Observation of the health system and health care system:**
   The fundamental definition of the health system and health care is used to figure out the boundaries of the system.

2. **Systemic Investigation**
   A “black box” view is taken to confirm the observation as well as to investigate the system from its functional and structural aspects. This means that the health system and health care system take in input and produce output. There is little here interest in what is happening in between.

3. **Determining the equity of health system/health care system for a population group through the inequity of health system/health care system:**
   Using the Systematic Analytical Mapping approach to the inequity of the system for a population group (for the identification of the challenges facing by this population group
with regard to the input into the health system, which would be translated into output of
the system for this population i.e. access and accessibility to health services)

4. Calculation of Inequity of health system/health care system
Formula for the calculation of the Strategic Equity Index, for a population group

Results and Discussions

1. Observation of the health system and health care system

What is a health system?
The 2000’s World Health report includes in the definition of a health system “all
activities whose primary purpose is to promote, restore or maintain health.”
The articulation of the following constitutes a health system: all the organizations,
institutions, and resources that are devoted to the production of health interventions with
formal care (family doctors, community health centres, hospitals…) and informal care
(e.g. community-based workers), as well as related practices outside the health area.

From the above definition of health system, it is clear that a health system is very broad.
For this exercise we will focus on the health care system, which is narrowed compare to
the health system. The health care system is the organized provision of the three level of
care: primary health care, secondary care and tertiary care. This gives us a clear idea of
the boundaries of our system.

The essential functions that support the functional aspect of a health care system are as
follows:
  • Provision of health services at the three levels of care
  • Generation and management of resources: providing resources to make the health
care system work (health care professionals, health care facilities, drug and
equipment, knowledge).
  • Finance: collecting revenues and allocating financial resources to various health
care system activities
  • Stewardship: developing and enforcing legislation, and providing strategic
directions for all stakeholders.

2. Systemic Investigation of health care system
The provision of health services, which is the key output of the health care system, is
produced through input from the remaining three above-mentioned essential functions
(generation and management of resources, finance and stewardship). From the functional
perspective, there is input into the health care system through stewardship, generation of
resource and collection and allocation of financial resources for health care system
activities, to produce output i.e. health services. Health care system activities are
undertaken in health care facilities (hospital, community health centres…). The
articulation of the health care facilities that undertake health care system activities
constitutes the structural aspect of the health care system.
The health care system is therefore a set of purposeful, organized and interdependent health care facilities, where health care system activities are undertaken to produce health services for their respective catchment population. The health care facilities are organized in health care sectors (e.g. hospital sector).

3. Determining the equity of health care system for a population group

Access to health services: The proportion of a defined population that has a health services facility within reasonable reach, which may be measured by distance, time, costs, or social and cultural factors. Access to health services reflects both the supply of and the demand for health services.

Accessibility of health services: The extent to which the population in need can use the health services. Examples of accessibility are:
- Geographical accessibility
- Economic accessibility
- Cultural accessibility
- Accessibility regarding organizational issues (availability of services).

Inequity in access and accessibility happens when the distribution of resources and facilities is uneven around a health services planning area (the planning area here could be as larger as a country, Regional Health Authority, or as smaller as a health sub-district). The inequity of the health care system will be the uneven distribution of resources and facilities across a defined health services planning area. The identification of the challenges that would face a population group for access and accessibility of health services helps in determining the inequity of the health care system for this population group. The Systematic Analytical Mapping approach is proposed for the identification for the identification of challenges faced by a population group XYZ for access to health services, for each health care sector of the health care system. The accessibility perspective is not covered here.

Systematic Analytical Mapping approach at a Regional Health Authority (RHA) level:

- Distribution of RHA Total Population, RHA’s XYZ population, and Number and Distribution of RHA Health Service Providers (HSP) by Planning Area.

- Distribution of RHA’s XYZ population, and Number and Distribution of the opportunities created by the regional health care system dedicated for the provision of Health Services to XYZ population group (XYZ’s HSPs) by Planning Area

- Distribution of RHA’s XYZ population, Number and Distribution of the opportunities created by the regional health care system (i.e. RHA HSPs)
and the opportunities created by the regional health care system for the population group XYZ (i.e. XYZ’s HSPs) by Planning Area, by RHA Communities and by RHA Municipalities

- XYZ population, Distribution of the opportunities created by the regional health care system (i.e. RHA’s HSPs) by RHAs Neighboring Planning Areas

4. Equity of Health Care System for the population group XYZ through the Calculation of Inequity of health care system

- Inequity (health sector)i : level of challenges (or inequality of opportunities) facing by XYZ for equitable access of (Health Sector)i services ( %)

- Numerator: \( \sum \) Inequity (Health Sector)i X Number HSPs (Health Sector)i

- Denominator: \( \sum \) HSPs (Health Sector)i

\( (i=1 \text{ to } n, \ n= \text{ number of sectors, for example hospital sector}) \)

- Level of inequity of Health Care System

\( (LIHS)= \frac{\text{Numerator}}{\text{Denominator}} \)

Health Care System Strategic Equity Index for XYZ = 1 – LIHS/100
Measuring the Inequality of a Health Care System: A Systems Perspective

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A METHODOLOGY FOR THE INTEGRATION OF ANCIENT AND MODERN SYSTEM THEORIES
--the portal for the 2000YRS OLD TAI CHI YIN-YANG SYSTEM THEORY

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ABSTRACT

System and control theories actually started thousands of years ago in many traditional cultures. In the Chinese culture, these theories appeared in many well-known classics including the I Ching book of changes, Tao De Ching of Lao-Tsu's Toaism, the Ten Wings of Confucius's annotation on I Ching, Taichi classic of Taichi exercise, the Noble Eightfold Path meditation technique of Buddha, the Yellow Emperor's Medicine Classic of Traditional Chinese Medicine and more. These classics guided the development of culture until the end of the Qing dynasty where many wars were fought and people were confused with the sudden influence of western culture. Even the practitioners of Toaism, Confucius, Taichi exercise, meditation, and Traditional Chinese Medicine question the truthfulness of these ancient theories. And they tried to adopt modern scientific theories to replace the ancient ones.

In the last few decades, some of the believers of the classics tried to illustrate these theories in terms of modern system and control theories. However, it is believed that the key essence of the link between the ancient and the modern theories are not clearly defined and illustrated. Without such a link, it is impossible for modern scientist to get the benefit of these ancient practical theories. A gateway or platform for the integration between these ancient theories and the integration with modern theories is urgently required. The integration of all theories in all areas, the search for "The Theory of Everything" is the hope of many leading scientists in different areas of research. It is believed that the essence of these ancient theories would be able to provide insights and new inspirations for the search of Unity of the universe.

Our research has been concentrated on the search of this missing link. In these papers, we present the result of our research in developing an integrated representation of these ancient theories in terms of modern system and control theories. The Good & Evil Yin-Yang chart has been developed for representing the state of the Taichi Yin-
Yang system. The generalization of these theories has been researched and a methodology has been developed for the integration of these ancient theories with modern scientific theories. This methodology enables the practical application of these ancient system and control theories in modern areas of interest, including areas in physical, social and biological sciences.

We hope that modern professional engineers and scientists can be the witness of the scientific and logical foundation of these ancient system and control theories. They are hard science instead of just "interesting" abstract philosophies.

Keywords: Ancient and Modern, Control System Theory, Differentiation & Integration, Research Towards General Theories of Systems, The Taichi Yin-Yang system, Traditional Chinese Medicine Differential Diagnosis-Cure process, Buddha, Dhamma.

INTRODUCTION

We humans want to analyze systems, to control systems, in order to fulfill our desires, and eliminate our disappointments, so as to achieve stability, efficiency, longevity and growth. The development of system theory in the past few decades has opened up a completely new simplified version of the real world (ISSS, 2007) (Bolton, 1992). In the first years of IT engineering study, the modeling of amplifiers simplified the tedious calculation and provide a very easy way to analyze those otherwise complicated electrical circuits. Terminology like Yin-Yang, Good-Evil, Water-Fire in Traditional Chinese Medicine make much more sense with this system viewpoint, than with the Western medicine's biochemical and anatomical point of view. In a university study of Traditional Chinese Medicine (TCM), the theory of TCM become more and more logical, but we still could not use modern science to clearly explain the theory until 15 years of study and practice. The use of the Good & Evil Yin-Yang chart allows the transformation of the traditional literal description of the theory into a graphical and mathematical one. More research revealed that similarities exist between this model and those modern physical, social and biological systems of modern days.

This model is introduced here to provide an ancient logical view of the systems in the universe and in the hope that it will inspire new research to better understand our world and ourselves. It is believed in traditional Chinese culture that this model is logical, correct, simple, efficient, practical and widely applicable (universal) to any systems either new/old, natural/man-made, or physical/abstract.

In order to be a widely applicable (universal) control theory, we must start from the very top level, our universe (Wu Chi). Taichi is differentiated from the universe but its integration with the environment is essential and hence the input and output of the systems arise. Traditional Chinese emphasize very much on the internal structure and the current state of a system, because both of them affects how the output behavior response to input influences.

The classic Water-Fire model (Heating Water system) is used as an example to illustrate the application of the theory and the meanings of different states of a system. The output behavior and input influences are all classified according to the
Taichi and the internal structure of the system. Rules of changes between the components of the system are discussed but it can only serve as an introduction to the books published in the last 2000 years. In conclusion, the steps on how to apply this theory to other scientific areas are listed, and a few diagrams of applications are shown which include social and biological sciences.

**WU CHI: THE UNIVERSE**

Taichi Yin-Yang theory is more than 5000-years old and hence contains lots of ancient terminology which will be explained along the way according to our research and understanding. The Chinese characters for the Universe is " Ô÷Ê " which means all space and time. Some scholars surmise that it is very difficult to precisely describe the universe because any "word" is just one part of the universe. The word "everything" become just "something", but the universe is

"Everything" + "Nothing" at "all times".

The Chinese characters of Wu Chi are ___ which is usually interpreted as "Nothing to the extreme" but the character _ mean a vast and dense forest that one cannot see any people within (CHU, 2007). It could also mean "Everything to the extreme". Hence Wu Chi should mean everything and nothing in the Universe in all space and time. Chinese further use ideas similar to modern logic and set theory in mathematics to describe the Universe. In Taoism Lao-tse of 590 BC called Wu Chi as Tao and he said the Tao should not be named, because once it is named, it is just become a particular thing at that moment. However, he felt that if he did not name it, others would not know what he was talking about. Hence he reluctantly called it Tao, and tried to use words of this world to describe it. Note that “Universe” is a word and hence is a set according to set theory, thus there exists "not universe" according to set theory.

The closest description of the Universe in Chinese culture is:

- "The Tao that can be explained (in words) is not the true and everlasting Tao. The name that can be named (in words) is not the true and everlasting name." (Laozi, 590 BC, Ch01)
- "Tao always does no action and does not do no action" (Laozi, 590 BC, Ch37)
- "Meditate at the place of nothing and everything" 7th level meditation technique (jhana) of Buddha (Buddhaghosa, 1956, p198).
- "Meditate at the place of not thinking and not not thinking" 8th level meditation technique (jhana) of Buddha (Buddhaghosa, 1956, p198).
- “They are neither Dhamma nor non-Dhamma.” (Buddha 2500BC Ch7) (Dhamma: the principle or law that orders the universe)

In terms of modern logic, these concepts are compared with the three fundamental principles of Aristotelian logic (Johnson 1998) using the format of predicate calculus:

1. Identity: ∀x (Ax ≡ Ax): A is A
2. Non-contradiction: \( \neg \exists x \ (Ax \land \neg Ax) \): A and non-A cannot both be the case

3. Either-or: \( \forall x \ (Ax \lor \neg Ax) \): Either A or non-A.

where A is a predicate, x is an individual, \( \neg \) is the negation (complement), \( \land \) is the intersection, and \( \lor \) is the union.

The second principle states that none of the object of interest (Nothing) can be A \( \land \) non-A at any one moment. And the third principle states that all of the objects of interest (Everything) is either A \( \lor \) non-A at any one moment.

Mathematics is a universal common language for human to think and communicate with each other. It must be consistent and logical. From the above simplest fundamental axiom of logic, it seems that a frame of reference, A, is required before thoughts and communications are possible. The complement non-A, which is the exact opposite of A, exists at the same time once A is identified. As soon as two objects are identified, there exists a relationship, say \( \land \), between them. And also at the same time there exists another relationship, say \( \lor \), which is the exact opposite of \( \land \). And the concept of "something", "everything", and "nothing" follows. Interestingly, these processes of identification and differentiation are exactly how our universe starts according to the teaching of Buddha 2500yrs ago. Differentiation is hence our source of awareness and knowingness, without which we cannot act, speak or even think.

Our interpretation of Wu Chi in the language of logic could be: With any frame of reference, Wu Chi includes all objects of interest inside, outside, both inside and outside, and not inside nor outside of the frame of reference, that is, Everything and Nothing at this moment. Extending these sets of fundamental axioms of logic to the concept of set theory, we will have the following axioms (Al Lehnen) (Johnson, 1998):

1. The Set A is set A.
2. The set not A, denoted by \( \neg \) is the compliment of the set A.
3. The set A intersected with \( \neg \) is the empty set, such that \( \neg \) and
4. The set A union with \( \neg \) is the Universal set, \( \neg \) such that \( \neg \) and

Wu Chi is all the objects of interest at all time, including no object. Therefore, it should include both the universal set and the empty set. Hence expressing Wu Chi in terms of set theory could be as follows:

\[
\text{Wu Chi} = "\neg \neg " = "\neg \neg " = "\neg \neg "
\]

But how can time be expressed? There is a believe that time is just an illusion, there exists only this moment, NOW, which includes the memory of both a particular frame of reference, say A, and the object of interest, say x. The concept of time comes from two characteristics of this universe, namely impermanence and memory.
Integration of Ancient and Modern

Impermanence is the ever changing nature of the universe, without which there is no time. The fundamental behavior of impermanence is the vibration of atoms. Memory includes human brain, drawings, writings, video, computer hard-disk, the rings of trees, the layers of earth, the layers of ice, etc, without which we do not realize the changes of the object of interest. Humans experience time by realizing the differences (change) between the memory and the "not memory", which include both the object of interest and the environment. Therefore \((A \cup A') \cup (A \cap A')\) already includes all time. Therefore,

\[
\text{Wu Chi} = (A \cup A') \cup (A \cap A')
\]

Figure 1 compares the Venn diagram of the above set and the diagram that traditionally describe Wu Chi (Zhow, 1072)

![Venn diagrams](a) (b)

Fig.1 (a) Venn diagram of Wu Chi and (b) the traditional diagram of Wu Chi.

Note that the expression of the universe in the ancient has the format of \((\text{not } A \cup \text{not } \text{not } A)\). According to set theory, this is the same as \((\text{not } A \cup A)\). However the ancients may be trying to tell us that the truth is not in \(A\) but it is also not in \(\text{not } A\). It is not everything and not nothing neither? The answer to this question may goes outside the scope of mathematics and any language, and is also outside the scope of this paper. However for the rest of the paper, we "reluctantly" use the notion \((A \cup \text{not } A)\) to denote Wu Chi.

**CHANGE: IMPERMANENCE**

Everything is changing, incidents are happening all around all the time. All changes are due to the changes of different Quarks, according to Quantum Physics (Feynman, 1985), or all due to the vibration of strings of different length according to string theory (length and vibration) (Hawking, 2001). However, changes do not matter to the universe itself according to the 1st law of thermodynamics (Law of conversation of energy) (Perrot, 1998). That is, nothing changes as a whole. Changes only matters to an observer because changes become signals to the observer. If there is no change, there is no time. Change is the difference between now and just now. Only observer "feels" time. The Universe as a whole has not time. Space and Time are relative concepts in
relativity (Hawking, 2001) and only become absolute to observers in their frame of reference. Nothing is permanent, except maybe the Universe. We humans want to keep things the way we want them to be, and hence try to control things.

**TAICHI: DIFFERENTIATION**

The first sentence of the Taichi exercise classic is "Taichi is born from Wu Chi, and is the mother of Yin and Yang" (Wile, 1995) (Wong, TBP b). Taichi is also an ancient Chinese terminology which could be interpreted as any particular set $A$. It can be an object, a movement, an incident, a thought, an idea, a method, a strategy, a tactic, a concept, a process, a system, energy, matter, signal (information), goal, etc.

Observers want to analyze and control set $A$ according to their desires. Hence differentiating set $A$ from $(A \cup \neg A)$. The power of Differentiation is Taichi and the decrease in entropy measures the power initiated by the Taichi. On the other hand, Integration comes naturally after Differentiation where entropy increases as the power dissipates back into Wu Chi and $A$ becomes $(A \cup \neg A)$ again.

Differentiation can reduce the entropy of set $A$. At a glance, it may contradict with the 2nd law of thermodynamics, but the observer is actually inserting energy into the system for the differentiation. It is similar to an air conditioner using power to differentiate cold and hot air. After the process of differentiation, anything in the universe become either $A$ or not $A$ from the viewpoint of the observer, which agrees with the third fundamental principles of Aristotelian logic (Either-or).

**ENVIRONMENT: INTEGRATION**

If the system $(A)$ can be isolated from its environment $(\neg A)$, then the changes within $A$ do not affect our goal (Taichi). In a way $A$ becomes another universe. If total isolation is achieved, there is no way we can observe if the system is still at our goal. The third law of thermodynamics states that as temperature approaches absolute zero, the entropy of a system approaches a constant (Perrot, 1998). If absolute zero is actually achieved, will the system become another universe with no changes to the observer?

Therefore, for us to observe the system it cannot be isolated and it is susceptible to influences from its environment. Influences will cause changes and possible the destruction of the system, and hence $A$ is impermanent. If $(A \cup \neg A)$ is the universe, then $A$ is imperfect without $(\neg A)$, but we humans "try" to make $A$ perfect!

Even a sealed glass ball of worms, plants and water, it still requires sunlight (absorb energy from the environment) during daytime and darkness during nighttime (dissipate energy to the environment) for it to work.
Integration is unavoidable in the analysis of systems because A is always part of (A union not A). A will always interact with (not A), the environment. Hence control is necessary to influence the system back to the goal initiated by Tai Chi. However, some people keep using the method of differentiation in their daily analysis and forget about the big picture, which should be an integral part of the whole analysis. Holistic analysis is extremely important in Chinese culture including Traditional Chinese Medicine. They call it the unity of human and the sky, which means the unity with their environment or the whole universe.

**INPUT INFLUENCE AND OUTPUT BEHAVIOR: THE INTERFACE WITH THE ENVIRONMENT**

We differentiate A from (A union not A) but A cannot sustain without (not A), its environment. Influences between A and (not A) are achieved through the interface of input and output of the system A.

Inputs of a system include routine and abnormal changes of time and space of the environment which will influence the system. Output of a system is the collection of all the behavior of the system.

The Ancient Chinese viewpoint of systems is a bit different from the modern system theory. Modern system theory considers a system as a black box with an input and an output, and identifying the input/output relationship is the most important task. Chinese regard all “black boxes” to have a common structure and the output behavior depends on the current state of the black box as well as the input. Different inputs will influence a system, and the output will behave accordingly. However, the same input feeding into the same system at a different time may have different output behavior because the state of the system changed. This state is represented by the common structure and can be determined from the output behavior.

In order to determine the exact state of the system, we need to analyze ALL the outputs, which is another area of the holistic point of view. However, in practice we only need to consider the most obvious and the subtlest behaviors, or the strongest and weakest behaviors, in order to exercise proper control or to understand the system.

In the analysis of the input influences or the output behavior, one should employ the holistic analysis of "Everything and Nothing" by observing both everything and nothing at both input and output. Nothing at the input is also an input influence. Nothing at the output is also an output behavior. But only when the observer is not sure if there is an input/output or not, then further observation is required.

**TAO: A UNIVERSAL STRUCTURE, TAICHI YIN-YANG**

When we play with toy bricks, the first thing we need to do is to learn about the basic building blocks and the building rules. Then we learn about the behavior of toy bricks
Integration of Ancient and Modern

and how they react to different influences. In real systems it is sometimes very hard to
determine the basic building components and the rule of interaction between them. The
Chinese found a basic structure for all the systems they encountered, and applied the
structure to different areas of knowledge in their culture. This basic structure was
extended into 64 more complicated structures. These structures were not further
divided because it was felt that going further would only complicate the analysis, and
the integrated big picture of being one, the unity would be lost (Confucius, 479 BC).

A universal system structure is very important to system analysis because we want to
develop a theory that can be applied to everything. A structure includes the
components, their predicates, and their relationships. Knowing this, the changes
between the components and the rule of changes can be studied. A state is a snapshot
of all the components at a given time, which can be used to determine the required
Input/Output relationship. Because of the property of integration, changes to one
component always affect other components.

How can set A be analyzed? Again, if we want to analyze something, we need to
differentiate; we need to make a comparison between at least 2 sets. Chinese applied
the same A and (not A) differentiation method again within set A. Let us now
differentiate set B and set (not B) within set A where all B is A:

\[ A = \{B, B \cap A\} = \{B, G\} \quad \text{where} \quad G = \{B \cap A\}. \]

In Ancient Chinese terminology, the simplest structure of Taichi is: Taichi = \{Yang, Yin\}, and can be described by the Venn diagram in Figure 2. "One Yin and one Yang is Tao" (Confucius, 479 BC).

![Fig.2 (a) Venn diagram A={(B,G) or Taichi={(Yin, Yang)} and
(b) the Traditional Chinese Taichi in action diagram](image)

Fig.2 (a) Venn diagram A={(B,G) or Taichi={(Yin, Yang)} and
(b) the Traditional Chinese Taichi in action diagram

Yin and Yang are the fundamental interacting components within any system (Taichi),
rather than just any arbitrary components within a system. Chinese have clear
definition for the properties for each one of them. In simple terms, we can understand

“Yin is the component that supports the system, and Yang is the component that
operates the system. “$\text{阴主静，阳主动。阴主静，阴主动。}$” (HuangDi,
206BC, Ch5) (Gou, 1999).

Figure 3 graphically shows the Taichi Yin-Yang structure of systems. There are many
examples in classic texts that describe rules of how these two components interact
with each other, including I Ching the Book of Changes (FuXi, 1122 BC), the
Confusions Ten Wings (Confucius, 479 BC), classics of Traditional Chinese Medicine (HuangDi, 206BC, Ch5) (Zhang 219) (Wiseman 2000), classics of Taichi exercise (Wile 1995) and many others. In other words, Yin and Yang are the functional differentiations of the two fundamental components of a system. It is a scientific classification method rather than a pure philosophy.

![Fig. 3 The basic structure of systems.](image)

Note that the same differentiation method can be applied within set B again and the same results follow. Hence, "size doesn't matter". This structure applies to the biggest system and the smallest system. No size limitations were imposed on set A (Taichi) in the analysis. Also the nature of set A can be any particular one in this universe, no matter how simple or complex. The level of set A is also unlimited from the most macroscopic level to the most microscopic level.

Once the Taichi is in action, Yin and Yang appears at the same time. E.g. an idea is a Taichi, and until the idea is put into action, Yin and Yang remain hidden. Therefore, the Taichi, Yin and Yang cannot be separated and form the simplest structure of any system in this universe. That is why Chinese say any system in this universe is a Taichi Yin-Yang system.

Western culture also has a similar concept: There are always two sides of a coin. Most people love one side of the coin and want to ignore the other side. Some people realize and accept both sides of the coin. But only a few clearly understand the definition of a coin: Head, Tail, and the Coin. Some people try to group all the Heads of different coins together, or group all the Tails of different coins together for analysis and get confused. The fact is that different coins have different Heads and Tails and each coin should be analyzed together its corresponding Head and Tail.

The same Taichi Yin-Yang structure can be observed in physical, social or biological sciences. For example in physical science, if we want to make a mechanical sound (Taichi), then we need to have an action force (Yang operated) and an reaction force (Yin supported) according to Newton's 3rd Law of Motion. An example in social science could be an economic system where the economy (Taichi) is composed of Demand (Yang operated) and Supply (Yin supported). In Traditional Chinese Medicine, the human body (Taichi) is composed of the materials of the body (Yin supported) and the function of the body (Yang operated). Research is ongoing on how to apply this theory to Economics, Business Management, Mechanical Physics, Unity theory of the forces in the universe, and more.
It is believed that this structure should also be able to analyze the phenomenon in Quantum physics. If quarks are the basic building blocks of all energy and matter, then energy and matter are both just the cohesion phenomenon of quarks and are just an impermanent illusion, which is deemed to fail and fall apart at some time. Remember that only (A union not A) could be permanent. Anything else is just A or (not A) which will constantly interact with each other, will integrate together again at some time, and then could be differentiated again at some other time by some observer. However, many people have the illusion that A can be permanent and keep analyzing the properties of A, keep controlling A to fulfill their desires. Traditional Chinese theories states that the final truth can only be found by releasing the unity, (A union not A).

RULES OF CHANGES: COMPONENTS’ RELATIONSHIPS

Now the Yin-Yang structure of a Taichi system has been examined, the predicates for each of these components and the relationship between Yin and Yang is studied. There are many possible changes between the Yin-Yang combo but here the basic and practical ones out of the publications of the last 3000 years will be looked at. These predicates are simply stated here but will be clearer when the Heating Water system is used as an example to illustrate the Taichi Yin-Yang system.

Unity of Yin-Yang: Taichi

Yin and Yang coexist and rooted in each other. They carry each other. Yin supports Yang and Yang operates Yin. Yin and Yang must be balanced by each other, the portion that cannot be balanced by the other component becomes excess. When Yin and Yang are balanced with each other, the whole system will be stable, be efficient, have longevity and be able to grow. Yin and Yang grow and diminish together.

Viscous Cycle

Excess components will ruin the system and will form viscous cycle of diminishing Yin and Yang. Nature will balance itself, only systems with feedback control will fall into the viscous cycle. For example, low spending causes high unemployment which then causes people to decrease their spending more.

Tolerance

Yin or Yang can tolerate a certain level of the component that cannot be balanced normally and would have become the excess.

Conductance/resistance/delay

The rate of change of the input maybe high and the resistance may prevent the effect from spreading to the whole system instantaneously which causes delay and stagnation.
STATE: SNAPSHOT OF THE SYSTEM

Yin and Yang are part of the universe and hence will change all the time. The simplest change is increasing or decreasing, compared to another instant of time or compared to Yin and Yang.

Taichi can be in a BALANCED state or in an Imbalanced state. A BALANCED system will be stable, efficient, long-life and able to growth. An Imbalanced system will be unstable, inefficient, short-lived and diminish.

An Imbalanced state at this level of analysis can either be due to more Yin than Yang or less Yin than Yang and these states are traditionally called COLD and HOT respectively. Hence we can represent the state of the set A in a matrix form as follows:

\[
A[Yin,\leq,Yang] = \text{BALANCED}.
\]
\[
A[Yin,>,Yang] = \text{COLD}.
\]
\[
A[Yin,<,Yang] = \text{HOT}.
\]

Control needs to be exercised to push the system back to a BALANCED state. However, there is not enough information at this level of analysis because it cannot be identified if the imbalanced states are caused by a problem with Yin or Yang. This is the same scenario in relativity and the frame of reference of the observer needs to be decided. If Yin and Yang are of different units, it is even impossible to compare. Therefore we need the frame of reference (Taichi) even just to determine COLD/HOT.

Before continuing further down the analysis tree, a simple model will be used as an example to illustrate the theory. The most famous and widely used model is the Water-Fire model, and here it will be referred to as the Heating Water System to suit modern scientific terminologies, as shown in Figure 4. For example, even with the same water with the same heat energy, to someone the water is HOT but to someone else the same water is COLD, because the HOT and COLD depends on the Taichi (frame of reference) of the system.

WATER-FIRE ANALOGY: THE HEATING WATER SYSTEM EXAMPLE

Taichi:

Our "goal" is to keep 50L of distilled water at 36.8°C so that our body feel good when we drink the water. We call this set A the set HeatingWater or the set HW. Here we assume that there is no usable heat energy in water at absolute zero temperature and there are 305MJ of usable heat energy in 50L of water at 36.8°C.

\[
\text{HeatingWater}\{50L,305MJ\} = \text{ideal BALANCED state}
\]
\[
\text{HeatingWater}\{\text{Water,Heat}\}
\]
\[
\text{HeatingWater}\{\text{Water,Fire}\}
\]
\[
\text{HeatingWater}\{\text{Yin,Yang}\}
\]
\[
\text{HeatingWater}\{\text{Material,Energy}\}
\]
Integration of Ancient and Modern

Fig. 4 The Heating Water system

Note that some systems cannot be balanced, for example a distilled water system of 50L with 200°C at normal pressure and expandable volume.

Identification:

The first step of applying the Taichi Yin-Yang system to any system A is to identify the Yin and Yang component in the system. Yin is the one that supports the system and here is the water. Yang is the one that operates and here is the Heat energy.

Changes:

The BALANCED state of our system is to have 50L of distilled water at 36.8°C.

The simplest change is an increase/decrease of our Yin-Yang combo in comparison with our goal. Quantity of water or quantity of heat energy can be increased/decreased in comparison to another set or another instance. Quantity has no meaning without comparison. Quality of our system involves both Yin and Yang and can be good/bad. A BALANCED system is good quality, while an IMBALANCED system of COLD/HOT is bad. The Quality can be further "quantify" as being high/low. A(40L,36.8°C) is BALANCED at low good quality, while (50L,36°C) is a COLD state at "low" bad quality. Nature of the current state can be COLD/HOT or BALANCED in comparison to the Taichi. Therefore quantity, quality and nature only exist in comparison (differentiation).

For simplicity, it is assumed for now that there are no changes initiated internally, e.g. chemical reaction, nuclear reaction, feedback reaction.

Current State:

The question of determining the source of the problem in the imbalanced system is now returned to. The 3 basic states are:

A[Yin,=,Yang] = BALANCED
A[Yin,> ,Yang] = COLD
A[Yin,<,Yang] = HOT
which depends on the definition of Taichi being used and each one can further divide into another Yin-Yang combo: Low/High. Some of the possible states of our example of Heating Water system are as follows:

1. HW{60L,305 MJ}->HW[60L,>305MJ] < 36.8°C = COLD
2. HW{50L,300MJ}-> HW[50L,>,300MJ] < 36.8°C = COLD
3. HW{50L,310 MJ} -> HW[60L,<,310MJ] > 36.8°C = HOT
4. HW{40L,305MJ} -> HW[40L,<,305MJ] > 36.8°C = HOT
5. HW{60L,366MJ}->HW[60L,=,366MJ]=36.8°C = BALANCED
6. HW{40L,244MJ} -> HW[40L,=,244MJ]=36.8°C = BALANCED

Once the Taichi is well defined, it can be determined if the imbalanced state is caused by the Yin or the Yang. Note that these states depend on the definition of Taichi being used and once it is changed, for example if 50°C, all the other states will be changed.

With the frame of reference of the observer (Taichi), we have two more possible states namely DEFICIENT and EXCESS. When Yin/Yang is too much in comparison to our Taichi, it is said Yin/Yang is in EXCESS, and when Yin/Yang is too little in comparison to our Taichi, it is said Yin/Yang is in DEFICIENT. Hence the problem can be pinpointed and proper control can be exercised to push the system back to the ideal BALANCED state.

1. HW[60L,>,305MJ] < 36.8°C = COLD = Yin EXCESS
2. HW[50L,>,300MJ] < 36.8°C = COLD = Yang DEFICIENT
3. HW[60L,<,310MJ] > 36.8°C = HOT = Yang EXCESS
4. HW[40L,<,305MJ] > 36.8°C = HOT = Yin DEFICIENT
5. HW[60L,=,366MJ]= 36.8°C = BALANCED = both Yin-Yang EXCESS
6. HW[40L,=,244MJ] = 36.8°C = BALANCED = both Yin-Yang DEFICIENT

Analysis is started by differentiating set A (Taichi) from (A union not A), the universe, and then differentiate Yin and Yang as the basic components of any systems. Then the COLD-HOT analytical method is used to investigate the changes of the Yin-Yang combo. Here the DEFICIENT-EXCESS analytical method is used to compare the changes of the Yin-Yang combo in reference to the Taichi. These are the six of the Eight-principals in the Traditional Chinese Medicine Differential Diagnosis-Cure Process. The other two will be introduced in the paper (Wong, TBP a). Figure 5 and Figure 6 show the basic structure of the Taichi Yin-Yang system using Venn Diagram and the Good & Evil Yin-Yang chart respectively. The use of graphical chats to represent the state of the Yin-Yang combo has been used in (Kaptchuk, 2000) (Wong, 2005) (Wong, 2006) (Wong, 2007a) and the traditional one is shown in figure 7. The one that is employed in our research was inspired by Mr Philip CHU and was modified to incorporate more properties of the practical changes in the Yin-Yang combo in different systems. It is called the Good & Evil Yin-Yang chart because it represents exactly those information of the system.
Integration of Ancient and Modern

Fig. 5 Venn Diagram (a) A={Yin,Yang} (b) A={Good,Evil}, and (c) A={Good Yin, Good Yang, Evil Yin, Evil Yang}

Fig. 6 The Good & Evil Yin-Yang chart. Fig. 7 The Traditional representation of the Yin-Yang BALANCED state of Taichi

Note that the same differentiation technique has been used throughout. In order to understand the DEFICIENT-EXCESS concept better, the Good and Evil components of the Yin-Yang combo will be introduced. The components that a system requires to achieve its goal (Taichi) are something "Good" for the system, and these components can either be DEFICIENT or not DEFICIENT in reference to the goal. The components that a system does not require to achieve its goal (Taichi) are something "Evil" for the system, and these components can either be in EXCESS or not in EXCESS in reference to the goal.

A larger matrix is now needed to describe the state of a system where the first row shows the state of the Good component of Yin and Yang and the second row shows the state of the Evil component of Yin and Yang. In our example

\[ HW[60L,> 0.305MJ] < 36.8 e^oC \]
\[ = HW [not DEFICIENT, > 0.305MJ] < 36.8 e^oC \]
\[ [EXCESS, > 0.305MJ, not EXCESS] \]
\[ = COLD = Evil Yin EXCESS \]

Rules of Changes

Unity of Yin-Yang: Taich
Water and energy coexist and rooted in each other. They carry each other. Water supports energy to stay within the system, and energy operates water to reach a certain temperature. The amount of water and energy must be balanced by each other according to the goal of Taichi. And the portion that cannot be balanced by the other component becomes excess. When the water and energy levels are balanced with each other, the whole system is said to be stable, be efficient, have longevity and be able to
grow according to our definition of Taichi. Water and energy grow (into the system) and diminish (out of the system) together.

Note that all changes of Yin and Yang affect each other and they also depend on the Taichi frame of reference. Together they form unity, which is another level of the holistic nature.

Viscous Cycle
To be discussed in our future research work.

Tolerance:
Figure 8 shows the possible changes when tolerance is introduced into the system. That could be done by allowing the temperature of the system to vary within a range instead of being fixed at 36.8°C.

For example, human body need to be balanced with the Taichi Alive{sleep 8h, =, work 12h}=IDEAL BALANCED. However, one can burn a few mid-night oil to write up papers while keeping one alive with Alive{sleep 4h, <, work 16h}=YIN DEFICIENT. This tolerance acts like a stretchable string between Good Yin and Good Yang in the Good & Evil Yin-Yang chart.

Fig. 8 The Taichi Yin-Yang systems with and without Tolerance.

Conductance/resistance/delay
Note that in the simple Heating Water model, the state of Yin or Yang can either be DEFICIENT or EXCESS or (not DEFICIENT & not EXCESS). However, this property will be gone once we introduce another special factor into the system: conductance/resistance/delay. Without resistance, increasing the water level will fill up the YIN DEFICIENT. However, the water may not be able to mix with the COLD water immediately and hence causing YIN EXCESS in one area while the other area is experiencing YIN DEFICIENT.

Fig.9 The Taichi Yin-Yang systems with and without Resistance.
Environment:
In our heating water system, water (Yin) evaporates to or condensed from the environment all the time depending on the state of the environment. Heat (Yang) is dissipated to or absorbed from the environment as well. The rate of change depends on the difference between the system (A) and the environment (not A) and the conductance between them.

Output Behavior:
Note that here Yin is the matter and the level can be measured with out sight, however, Yang is energy that cannot be measured with our sight and we need the help of some other sensors (matter) to deduct the level of Yang.

The possible static states of a system have been studied. In the next paper (Wong, 2007d) the Rule of Changes of a Taichi Yin-Yang system will be looked at in order to understand the dynamic changes of a system.

\[
\text{New state}[\text{Yin, comparison, Yang}] = \text{Old state}[] + \text{Input state}[] - \text{Output state}[]
\]

The Good & Evil Yin-Yang chart can now be used to show the possible states of the Taichi Yin-Yang system. There are eight possible Good states and eight possible Evil states and hence a total of 64 states for the system. The simplified version is shown in Figure 10.

![Fig. 10 The Good & Evil Yin-Yang chart of basic states.](image)
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Excretion
Note that excretion is also part of the behavior and they can be either Good or Evil where Good excretion composes of rubbish and Evil excretion composes of essence of the system. The response of a system to a particular input depends on the current behavior of the system, which is the current state of the system. It also depends on the other current inputs. Once again this is another holistic point of view. Sometimes a special input is required to stimulate the system in order to more accurately determine the current state of the system, something similar to frequency or impulse response in modern control theory. There are standard special sets of behavior for the BALANCED state, the COLD state, the HOT state, the YIN DEFICIENT state, the YANG DEFICIENT state, the YIN EXCESS state, and the YANG EXCESS state. They will all be discussed in more details in (Wong, 2007d).

Input Influences:

Input to this Heating Water system can be pure heat energy, pure water, or water with some heat energy.

All influences must be studied for their nature and strength in reference to the system before they can be used to influence the system accordingly when required. This kind of study allows the use of a combination of influences as a formula for the most effective control in different or difficult states.

All influences can only affect the levels of the four components: Good Yin, Good Yang, Evil Yin and Evil Yang. Input Influences are classified according to how they affect these for levels and form the COLD-HOT Influence Spectrum, which will all be discussed in more details in (Wong, 2007d). Figure 11 shows the three basic classes of influences.

Feedback Influences:
Feedback is intentional or unintentional self control according to some rules that can or cannot be changed. These rules can be seen as the "habits" of the system and such systems may be considered to have "life". In modern system theory systems with feedback are called closed-loop systems.
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Time Influence:
The environment changes with time, some are regular and some are irregular. Figure 12 shows the source of Input Influences.

Fig. 12 The Sources of Input Influence

The complete Taichi Yin-Yang system diagram from an observer point of view has been developed in our research and different areas of applications is our ongoing research. It is believed that this is "The Structure of Everything" but extensive research is required to apply this structure to different physical, social and biological sciences. Figure 13 shows the general steps for the application of the Taichi Yin-Yang system. The heating water system example in this paper illustrated an application of the Taichi Yin-Yang system in the field of physical science, while Figure 14 and 15 show the application in the field of biological science (human health) and social science (economic system) respectively.

CONCLUSION

(A union not A) is the closest description of the universe, Wu Chi. Similar descriptions appear in the Chinese, Indian and other traditional cultures. Taichi is the goal of a system and must be clearly defined as a frame of reference in order to identify the Yin and Yang, and Good and Evil components of a system. Even if the Taichi Yin-Yang system is differentiated from the universe for analysis, its environment is always an integral part of the system. In a way, the environment of the system is another system in a way, and hence can also be represented by the Good & Evil Yin-Yang chart. Current state of a system can be COLD/HOT, DEFICIENT or not, or in EXCESS or not. Hence the system could be in one of the 64 different states.

The output behavior of each one of these states is different and hence the input responses are different. The internal changes caused by the interaction between these special components has been explored for the last 5000 years in China, and the most important ones include the Yin-Yang viscous cycle, conductance/resistance delay in transfer, and the tolerance of imbalances. The input influences can be classified into a COLD-HOT influence spectrum according to the definition of Taichi. However, the inputs can be external factors, necessities, strategies, time or the internal feedback.

Following the simple 15 simple steps, one can apply the theory to any kind of system for analysis. The only key is thoughtful differentiation of the system of interest according to the predicate of each of the Yin, Yang, Good and Evil component.
**FURTHER WORK**

This is merely the introduction of the Taichi Yin-Yang system. 5000 years of investigation has further enhanced the theory. But once this basic structure is understood, one can conduct further research on the classics to explore the whole field of the theory. More research should be done in this field because of its simplicity, efficiency and universality. Modern science would benefit very much from the help of this ancient theory. Anyone who conducts further research on this theory should translate into a major breakthrough in their field of science. Research has also be done and is ongoing in applying the theory to physical sciences such as the unification of basic forces (Wong, 2007c), social sciences such as economics (Wong, 2007c) and meditation (Wong, 2007e), and biological sciences (Wong, 2007a) (Wong, 2007b) (Wong, TBP c).

**ACKNOWLEDGMENT**

We would like to take this opportunity to thank our Traditional Chinese Medicine mentor Mr. Philip CHU who inspire us with TCM and Taichi exercise, and established the Good & Evil Yin-Yang chart, which is what the research is based on. We would also like to thank Mr S.N. Goenka and his organization for teaching us the Vipassana meditation technique which allows us to think properly and integrate all the theories together. Moreover, many thanks to Blue River Creative Studio for revamping the Good & Evil Yin-Yang to make it more appealing to the general public. Lastly thanks to all our friends and colleagues for all their help.

**REFERENCES**


The Application of the Taichi Yin-Yang System Step 1-15

Fig.13 The Application of the Taichi Yin-Yang system Step 1-15
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**Fig. 14** The application of the Taichi Yin-Yang system on human health system (biological science).

**Fig. 15** The application of the Taichi Yin-Yang system on Economic system (social science)
INTEGRATED SYSTEM DYNAMICS: ANALYSIS OF POLICY OPTIONS FOR TOBACCO CONTROL IN NEW ZEALAND

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ABSTRACT

This paper provides an overview of the system dynamics model that has been developed to assist the Ministry of Health to evaluate the dynamic consequences of tobacco control policies in New Zealand. The model consists of 4 sectors: population; smoking prevalences; second hand smoke, and tobacco attributable deaths. The model is simulated for 20-30 years into the future. The simulation package used is ‘iThink’, and a user interface is presented for policy analysis. A range of illustrative scenarios are provided, including: business as usual; fiscal strategies involving less affordable cigarettes; harm minimisation strategies involving either less addictive cigarettes or less toxic cigarettes; and combinations of the above policies. The main output variables (performance measures) include current smoking prevalence, tobacco consumption, and tobacco attributable mortality. Finally areas for future model enhancement are identified.

Keywords: system dynamics; dynamic simulation; tobacco policy model; tobacco control policies; New Zealand Ministry of Health.

INTRODUCTION

This paper describes a system dynamics model that has been developed to help the Ministry of Health (MOH) to evaluate the dynamic consequences of tobacco control policies in New Zealand (NZ).

Traditional epidemiological methods (eg randomised control trials, cohort studies) help us understand the parts (eg effectiveness of nicotine replacement therapy) but not the whole. Tobacco use can be thought of as a ‘system’ containing emergent properties, complexity, and nonlinear dynamics.

Traditional epidemiological methods deal with complexity by breaking the issue down into parts simple enough to be controlled (randomised control trials) or observed (cohort or case control study). System dynamics (SD) deals with complexity by abstracting the key elements and simulating their dynamic inter-relationships (using multiple simultaneous differential equations).

The focus of an SD model is on the behaviour of the system as a system. Elements are retained only if necessary, and only relevant attributes incorporated.
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“Everything should be made as simple as possible – but not simpler”
- Albert Einstein

The specific objectives of the SD tobacco control model are:

(a) to support evidence-informed tobacco control policy;
(b) to provide a decision support tool when considering strategic policy options in tobacco control; and
(c) to assess the utility of system dynamics in formulating public health policy in the NZ context.

MOH has a statutory responsibility to monitor use of, and harms caused by, tobacco products. Also this is required as signatory to the WHO Framework Convention on Tobacco Control (WHO, 2005).

Previous system dynamics studies related to tobacco policy includes: the DYNAMO based system dynamics modelling work at MIT in the late 1970s and early 1980s on the impacts of smoking by Roberts et al. (1982); the Markovian system dynamics computer based simulation model developed in the USA by Tengs et al. (2001a & b; 2004a & b), Ahmad (2005) and Ahmad & Billimek (2005) for analyzing tobacco related policies; the computer simulation model called SimSmoke developed by Levy et al. (2006a, & b) to assess the impacts of a broad array of public policies related to tobacco control; and the system dynamics pilot study by Cavana & Clifford (2006) at NZ Customs Service analysing the collection of tobacco excise duties and cigarette smoking in NZ.

The general approach used in this study follows the five phase integrated approach in Table 1, as outlined by Maani and Cavana (2000, 2007), following the general approach of the system dynamics methodology (e.g. see Forrester, 1961; Coyle, 1996; Sterman, 2000):

Table 1: Systems thinking and modelling methodology & ISSS 07 conference theme

(integrated systems science)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Problem Structuring</td>
</tr>
<tr>
<td>2</td>
<td>Causal Loop Modelling</td>
</tr>
<tr>
<td>3</td>
<td>Dynamic Modelling</td>
</tr>
<tr>
<td>4</td>
<td>Scenario Planning and Modelling</td>
</tr>
<tr>
<td>5</td>
<td>Implementation and Organisational Learning</td>
</tr>
</tbody>
</table>

Source: Maani and Cavana (2000, Table 2.1, p16)
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The theme of this conference is “Integrated Systems Sciences: Systems Thinking, Modeling and Practice”. ISSS (2007) defines this theme as follows: “It attempts to promote systems sciences as an approach to complexity in a broad sense, identified in organizations, communities and societies, and their environments, in such a holistic and integrated way that we draw on all of systems sciences from systems thinking and systems modeling to systems practice.” While SD does not draw on all the systems sciences, it is certainly concerned with the scope of the integrated systems sciences outlined by the ISSS conference organisers. The five phase integrated SD approach outlined in Table 1, shows the relationships to the integrated systems sciences as follows (ISSS, 2007):

“Systems thinking promotes holism as its primary intellectual strategy for handling complexity, whether the approach is hard or soft, carried out by academia or practitioners. Instead of analyzing complex systems by breaking them down into their parts, it advocates studying them as ‘wholes' using systems concepts…” [this relates to the problem structuring and casual loop modelling phases summarised in Table 1].

“Systems modeling aims at describing, analyzing and prescribing a real entity or phenomenon by constructing a variety of systems models. It includes mathematical models, conceptual models, computer models and simulation tools…” [this relates to the casual loop modelling, dynamic modelling and scenario planning/modelling phases summarised in Table 1].

“Finally, systems practice, or practical applications of systems thinking/ideas, is the greatest success of systems sciences in recent years. It has shown that systems sciences have the ability to translate theoretical notions into the practical domain through the use of systems methodologies, models and methods…” [this relates to the scenario planning/modelling and implementation/organisational learning phases summarised in Table 1].

This paper outlines progress to date of the tobacco policy modelling study. The next section provides the overview causal loop diagram that provided the conceptual framework for the development of the stock flow diagrams and simulation model outlined in the following section. The main part of this paper outlines a range of scenarios with the tobacco policy model describing the experiments and the model performance measures for a range of tobacco control policies. Finally some limitations and areas for further work are outlined in the concluding section.

CAUSAL LOOP MODELLING

The overall causal loop diagram for the model is provided in Fig 1. This diagram shows the population aging chain and the various categories of smokers and non-smokers. The feedback effects of adult smokers and peer group smokers can be clearly seen, and the effects of various tobacco control measures on initiation rates (smoking starts), quitting smoking, and smoking intensity can also be observed in this diagram.
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Figure 1: Causal Loop Diagram for the NZ Tobacco Policy Model

Key: i = smoking initiation rate; b = birth rate; e = exposure to second hand smoke; q = net quit rate; m = never smoker mortality rate; RR = relative risks of mortality; c = current smokers; s = second hand smoke; x = ex-smokers.

This diagram provides the conceptual framework for the development of the 4 sector system dynamics simulation model, briefly outlined in the following section. It must be emphasised that this model represents work in progress, and the authors are continuing to develop it along the lines outlined in the final section of this paper.

Nevertheless, the model is currently very useful for demonstrating the impact of a range of tobacco control policies. In some cases the output measures have been summarised outside the SD model. These performance metrics will ultimately be endogenised within the model.

**DYNAMIC MODELLING**

**Overview of the simulation model**
The system dynamics simulation model consists of 4 sectors: population; smoking prevalences; second hand smoke; and tobacco attributable deaths.
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The tobacco sector consists of population aging chains broken down into approximately 10 year age groups representing stocks of 'never smokers', current smokers', 'recent ex-smokers', and 'non recent ex-smokers'. Flows are provided for births, aging between cohorts, initiation and net-quitting smoking, and mortality associated with smoking & ex-smoking related risks. The prevalences sector calculates ratios for each of the stocks or combination of age related stocks in the population sector. The second hand smoke sector calculates the exposure and mortality associated with second hand (passive) smoking by age group in NZ. Finally the tobacco attributable deaths sector summarises the mortality associated with smoking and second hand smoke by age cohort in NZ.

Only the simplified stock flow diagram for the population sector will be provided in this paper (see Figure 3). The variable names are classified as acronyms, where for example:

- 10G = age group from 10 to 19 years old
- NS = never smokers
- CS = current smokers
- XSR = recent ex-smokers
- XSNR = non recent ex-smokers
- Births = annual births
- D = annual deaths
- NSD 70G = annual deaths of never smokers in the 70 plus age group
- NS to 10G = annual aging into the age group starting at age 10 (flow - aging between the 1st two age cohorts)
- q = annual net-quit rate (ie rate of quitting smoking less restarting smoking)
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- \( m \) = mortality rate
- \( ir \) = initiation rate
- \( RR_{CS30T69G} \) = relative risk of mortality of current smokers in the 30 to 69 year old age group

The model is developed using the \textit{iThink} v9.01 dynamic simulation software package (iSee systems, 2005). The sources for the data used to initialise the model are summarised in Table 2 below. The model will be available from the authors when the project is completed. The model can be simulated for 50 years, although the focus is on the medium term, 20-30 years into the future.

Table 2: Initialising the Tobacco Policy Model

<table>
<thead>
<tr>
<th>Prevalence (current, ex-smoking)</th>
<th>NZHS 02/03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiation rate (and responsiveness to parental and peer role modelling)</td>
<td>Clements (modelled from Aus and NZ data 1990s)</td>
</tr>
<tr>
<td>Net quit rates</td>
<td>Clements (as above)</td>
</tr>
<tr>
<td>Smoking intensity distribution</td>
<td>NZHS 02/03</td>
</tr>
<tr>
<td>Never smoker mortality rates</td>
<td>( m_c = m / [p_c (RR_c - 1) + p_x (RR_x - 1) + 1] )</td>
</tr>
<tr>
<td>RR current smokers (by duration and intensity)</td>
<td>CPS II (duration = age –15)</td>
</tr>
<tr>
<td>RR ex-smokers (by duration)</td>
<td>Clements</td>
</tr>
<tr>
<td>RR SHS exposure</td>
<td>NZCMS (Ministry of Health 2005)</td>
</tr>
<tr>
<td>Never smokers exposed to SHS</td>
<td>NZHS 02/03 (Ministry of Health 2004)</td>
</tr>
<tr>
<td>Population estimates and projections (including mortality trend)</td>
<td>SNZ</td>
</tr>
</tbody>
</table>
Figure 3: Simplified stock flow diagram for the population sector.
Calibrating and testing the model

The model was subjected to a number of verification and validation tests. Firstly we calibrated the model by checking that the base case reproduced current prevalence by age, consumption and tobacco attributable mortality (TAM) – this involved minor tweaking of initiation and quit rates. The ‘validation’ experiments included:

- Base case reproduces observed prevalence, consumption, TAM
- Business as usual (BAU) scenario reproduces recent trend in prevalence
- Prevalence increases if never smoker mortality decreases or relative risk (RR) related to smoking decreases
- Prevalence, consumption and TAM behave appropriately if initiation and quit rates change
- Youth smoking prevalence changes appropriately if parental / peer feedbacks change
- Second hand or passive smoking (SHS)–attributable mortality changes appropriately if living arrangements change.

SCENARIO PLANNING AND MODELLING

The user interface for the model (or management flight simulator) is provided in Figure 4. This shows the parameters that can be adjusted readily by the public health physicians, policy analysts, managers, or others experimenting with the model. Also sensitivity analysis and scenario analysis can be undertaken by undertaking ‘what if’ experiments with the user interface ( e.g. changing the assumptions regarding adult and peer group effects on the smoking initiation rates, and the relative risks of mortality associated with current smokers, ex-smokers and second hand smoking).
A range of illustrative scenarios are provided, including:
- business as usual;
- fiscal strategies involving less affordable cigarettes (through raising the excise tax rate on tobacco products);
- harm minimisation strategies involving either less addictive cigarettes or less toxic cigarettes; and
- combinations of the above policies.

Table 3 contains the elasticities and sources for the major scenarios with the model. The main output variables (performance measures) include current smoking...
prevalence (rate and count), tobacco consumption (per capita and total NZ), and tobacco attributable mortality (rate and count).

Table 3: Elasticities (hazard functions) for the experiments

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Outcome</th>
<th>Elasticity</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affordability</td>
<td>RR Initiation rate</td>
<td>-0.50 -0.50 +0.50</td>
<td>Chaloupka 2002</td>
</tr>
<tr>
<td></td>
<td>Net quit rate</td>
<td></td>
<td>Nicolas 2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Forster 2000</td>
</tr>
<tr>
<td></td>
<td>RR Initiation rate</td>
<td>+0.10 -0.50 +0.67</td>
<td>Henningfield 2005</td>
</tr>
<tr>
<td></td>
<td>Net quit rate</td>
<td></td>
<td>Gray 2005</td>
</tr>
<tr>
<td></td>
<td>RR Initiation rate</td>
<td>-0.80 +0.08 -0.33</td>
<td>Tengs 2004</td>
</tr>
<tr>
<td></td>
<td>Net quit rate</td>
<td></td>
<td>Gray 2006</td>
</tr>
</tbody>
</table>

Business as usual (BAU) scenario

The key model output for the business as usual (BAU) scenario (or base case) is provided in Table 4.

Table 4: Major performance measures for BAU scenario

<table>
<thead>
<tr>
<th></th>
<th>Prevalence</th>
<th>Consumption</th>
<th>TAM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rate</td>
<td>Count</td>
<td>Rate</td>
</tr>
<tr>
<td>2011</td>
<td>22.3</td>
<td>761</td>
<td>977</td>
</tr>
<tr>
<td>2021</td>
<td>21.6</td>
<td>769</td>
<td>946</td>
</tr>
<tr>
<td>2031</td>
<td>21.0</td>
<td>775</td>
<td>920</td>
</tr>
<tr>
<td>Change</td>
<td>1.3</td>
<td>(14)</td>
<td>57</td>
</tr>
</tbody>
</table>

The BAU scenario is of interest for 2 reasons:

- Target setting
- Counterfactual against which all intervention scenarios must be compared (it is invalid to compare the outcome of intervention in the future with the situation today – the only valid evaluation is to compare the BAU and intervention trajectories over an appropriate time span)
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Note that model predicts a very slow rate of decline in prevalence – 1.3 percentage points over 20 years or less than 0.1 percentage point per year. Other features are:
- Per capita consumption falls from approximately 1000 CE/yr\(^1\) today to about 900 CE/yr.
- Attributable mortality rate falls by less than 0.5% per year while count remains essentially stable (reflecting demographic trends).

Note that these estimates are oversimplified, because the model as currently constructed does not age standardise rates, nor does it allow for changes in fertility and net migration. Therefore it underestimates population growth and fails to fully reflect changes in population age structure (and doesn’t capture changes in population ethnic composition at all).

**Less affordable cigarette scenario**

*Scenario:* 20% reduction in affordability from 2006, real value maintained thereafter.

*Parameters:* Relative risk (RR) current smoking 10% decrease; initiation rate 10% decrease & net quit rates 10% increase.

Generally for this type of scenario, econometric modelling is better than SD modelling (since NZ has long time series for price, tax, costliness and consumption). Nevertheless, SD has some advantages especially in linkage to health impacts.

This scenario is based on the recent history of price increases in NZ: 1991 (21%), 1998 (15%), 2000 (23%) – so a 20% reduction in affordability (increase in costliness) is realistic (also discussed in Cavana & Clifford, 2006).

This scenario involves a step change in affordability in 2006, sustained thereafter (in terms of minutes of labour at the average wage rate required to purchase a standard pack of cigarettes or quantity of loose tobacco) by annual adjustments for inflation and increase in real incomes.

*Assumptions:*
- no price manipulation by tobacco companies
- improvement in access to cessation services accompanies tax increases
- minimal increase in brand switching, switching from manufactured cigarettes to RYO, smuggling and home growing of tobacco
- tobacco products removed from CPI

What will be the impact on smoking behaviours?

Tobacco economists talk about 3 elasticities:
- total price elasticity of demand (consumption elasticity)
- prevalence elasticity (we need to decompose this into ‘quitting elasticity’ and ‘initiation elasticity’)

---

\(^1\) A 1 CE = 1 manufactured cigarette or 1 gram of ‘roll your own’ (RYO) tobacco equivalent.
Integrated system dynamics: analysis of tobacco control policies in New Zealand

- conditional demand elasticity (reduction in cigarettes/day among continuing smokers - intensity elasticity)

Meta-analysis (Chaloupka, 2002):

- short term consumption elasticity – 0.4 more recent studies suggest – 0.5
- long term about twice this i.e. – 0.8 to – 1.0
- about half comes from prevalence reduction and about half from cutting down
- so intensity elasticity and hence impact on RRc (and consequently also RRx and RRs) about - 0.5 (only interested in long term).

Sophisticated duration analyses (eg Nicolas (2002) for Spain; Forster & Jones (2000) for Britain) show that a permanent 10% increase in costliness will reduce duration of smoking by about 10%. This translates into an increase in the probability of quitting of about 5% so quitting elasticity is about +0.5.

Unfortunately the few direct studies of price impact on youth initiation probability have given conflicting results. However, since changes in youth smoking prevalence largely reflect changes in initiation, we can conclude that initiation elasticity = prevalence elasticity for youth.

So initiation elasticity is about – 0.5 (consistent with estimates from Nicolas (2002) and Forster & Jones (2000) analyses)

We of course have an inbuilt check on the validity of these elasticity estimates: running the model for the long term (say 20 yrs), our scenario of 20% affordability reduction should generate about 20% reduction in consumption (long term consumption elasticity of –1.0) and about 10% reduction in prevalence (long term prevalence elasticity of –0.5).

Table 5: Model output for the less affordable cigarette scenario

<table>
<thead>
<tr>
<th>Year</th>
<th>Base</th>
<th>Experiment</th>
<th>Difference</th>
<th>Percentage Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>22.3</td>
<td>761</td>
<td>21.9</td>
<td>747</td>
</tr>
<tr>
<td>2021</td>
<td>21.6</td>
<td>769</td>
<td>20.3</td>
<td>726</td>
</tr>
<tr>
<td>2031</td>
<td>21.0</td>
<td>775</td>
<td>19.1</td>
<td>706</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Base</th>
<th>Experiment</th>
<th>Difference</th>
<th>Percentage Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>22.3</td>
<td>761</td>
<td>21.9</td>
<td>747</td>
</tr>
<tr>
<td>2021</td>
<td>21.6</td>
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<td>20.3</td>
<td>726</td>
</tr>
<tr>
<td>2031</td>
<td>21.0</td>
<td>775</td>
<td>19.1</td>
<td>706</td>
</tr>
</tbody>
</table>

Table: Model output for the less affordable cigarette scenario
Integrated system dynamics: analysis of tobacco control policies in New Zealand

The first point to note is that the long term consumption reduction is close to the 20% expected, and long term prevalence reduction is close to the 10% expected (slightly more if compared to the 2006 base rather than to the BAU scenario – but the latter is the correct counterfactual).

Interestingly, this produces a slightly lower attributable mortality reduction of about 8%, but this does increase to around 10% if reductions in RRx and RRshs are modelled as well as RRe. (relative risks – ex-smokers, second hand smokers, and current smokers respectively).

Note that there is a substantial short term drop in consumption – largely due to cutting down. Longer term, about half the drop in consumption is due to cutting down and half to prevalence reduction (mainly quitting).

Overall summary is that a feasible increase in costliness, if sustained over the long term, could produce major health gain. Specifically, a sustained 20% increase in costliness could yield 9% greater reduction in prevalence, 18% greater reduction in consumption, and most importantly, at least 8% greater reduction in attributable mortality than would otherwise be the case.

While not without political and other risks, there is some evidence that these risks could be managed. This is not the case for the harm minimisation examples we turn to now.

Harm minimisation scenario

- Compatible with other national drugs policies
- “The present situation in which the most toxic form of nicotine delivery is the least regulated, is unacceptable from a public health perspective” (WHO, 2002)
- Serious risks – expansion of the tobacco or nicotine markets, compensatory smoking, gaming by industry, inability to audit (inadequate testing standards)

Harm minimisation (HM) is the new frontier in tobacco control. Keep in mind that HM strategy would be superimposed on existing tobacco control strategies and would not operate in isolation from efforts to reduce youth initiation into tobacco use, provide cessation services for addicted smokers, or protect non-smokers from exposure to SHS.

Despite this, HM has serious risks – as shown by the experience in the 1970s, which no-one would like to repeat.

In reality, accurate and independent measurement and monitoring of addictiveness and toxicity of tobacco smoke is an essential precondition to any regulation of product modification – and it is not at all clear that such testing is technically possible at the present time.

We must emphasise that our objective with this paper is merely to illustrate what can be simulated with the SD model – policy decisions regarding harm minimisation strategies would need to take other factors into account as noted above.
Integrated system dynamics: analysis of tobacco control policies in New Zealand

Less Addictive Cigarette (RNC) Scenario

Scenario: 30% reduction in nicotine content implemented progressively from 2006 to 2011
Parameters: RR current smoking 3% increase; initiation rate 15% decrease; and net quit rates 20% increase.

The scenario involves a 30% reduction in addictiveness, assuming that there was a valid and reliable way to measure this. (A 30% reduction in nicotine content of tobacco is technically perfectly feasible). 30% is chosen so as not to deny NZ smokers their nicotine fix, but merely to remove the ‘excess’ nicotine in NZ cigarettes.

Although this is represented as a reduced nicotine content cigarette, addictiveness could be decreased by changing the content of additives such as acetaldehyde and ammonia (which affects the ratio of freebase to ionised nicotine by altering smoke pH) instead.

Note that we are not simulating the “Henningfield approach” (Henningfield et al 2004) – denicotinisation – which is probably unacceptable to smokers and politically unrealistic at the present time. Instead, we are aiming only to reduce the excess nicotine in NZ cigarettes so that smokers in the future will experience, on average, a less fierce addiction or level of tobacco dependence than is currently the case.

Assumptions:
- tobacco dependence is not a threshold (all-or-nothing) phenomenon, but displays a continuous dose-response relationship (i.e. there is gradation in the level of tobacco dependence).
- reduction in addictiveness of cigarettes (manufactured cigarettes and RYO) will be accompanied by further improvements in access to NRT eg patches and gum.
- since smokers will still be able to get their ‘nicotine fix’ there will be minimal increase in contraband or home grown tobacco use.
- for similar reason, there will be at most partial compensatory smoking
- ventilated filters will be banned (such filters facilitate compensatory smoking)

There are few studies to go on in the literature, and it is important to note that this approach has never actually been implemented anywhere.

Our hazard functions (elasticities) are based on a paper by Tengs et al. (2004b), from which we estimate that a 30% reduction in nicotine content may reduce smoking prevalence by about 15% i.e. a prevalence elasticity of about -0.5. According to Tengs and other workers, the effect of a less fierce addiction will be greater on quitting than on initiation.

We translate this into a quitting elasticity of about +0.67 and an initiation elasticity of about -0.5 (which jointly should yield about the expected prevalence elasticity).
Integrated system dynamics: analysis of tobacco control policies in New Zealand

The literature is inconsistent as to the extent of compensatory smoking to be expected. Since we are removing only ‘excess’ nicotine, we assume that most smokers will not need to smoke more intensely or efficiently to get their required nicotine dose, but will adapt with little difficulty to the lower dose.

Based on Tengs et al., we consider compensatory over smoking will be only partial, corresponding to an RRe elasticity of about +0.1. (Note that if this was mediated entirely though intensity, it would be equivalent to an increase in mean cigarettes per day from 12.0 to 13.2).

Unlike the affordability elasticity estimates, we acknowledge that the evidence base for these ‘RNC’ (reduced nicotine content) hazard function estimates is poorly developed and there is a much greater need for sensitivity analysis in this scenario.

Table 6: Model output for less addictive cigarette (RNC) scenario

<table>
<thead>
<tr>
<th></th>
<th>Prevalence</th>
<th>Consumption</th>
<th>TAM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rate</td>
<td>Count</td>
<td>Rate</td>
</tr>
<tr>
<td>2011</td>
<td>base</td>
<td>22.3</td>
<td>761</td>
</tr>
<tr>
<td></td>
<td>exp</td>
<td>22.0</td>
<td>749</td>
</tr>
<tr>
<td></td>
<td>diff</td>
<td>0.3</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>% diff</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>base</td>
<td>21.8</td>
<td>769</td>
</tr>
<tr>
<td></td>
<td>exp</td>
<td>19.9</td>
<td>709</td>
</tr>
<tr>
<td></td>
<td>diff</td>
<td>1.7</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>% diff</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>2031</td>
<td>base</td>
<td>21.0</td>
<td>775</td>
</tr>
<tr>
<td></td>
<td>exp</td>
<td>18.2</td>
<td>673</td>
</tr>
<tr>
<td></td>
<td>diff</td>
<td>2.8</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>% diff</td>
<td>13.3</td>
<td></td>
</tr>
</tbody>
</table>

Given that we are modelling a gradual and progressive reduction in nicotine content from 2006 to 2011, we would not expect much difference between the intervention and BAU scenarios by 2011, and indeed this is confirmed. Prevalence drops marginally more than would otherwise have been the case, but consumption is slightly up because of compensatory smoking and attributable mortality is essentially unchanged.

Over the next 20 years, however, the less fierce addiction enhances quit rates and also has some effect on initiation, so prevalence drops quite steeply – reaching about 13% less than the BAU counterfactual (close to the 15% we would expect given the elasticities used).

However, consumption falls slightly less than this and attributable mortality falls very much less (about 5% less than expected after 20 yrs) reflecting partial compensation. Nevertheless, this still amounts to over 200 fewer attributable deaths per year than would otherwise have been the case.

Interestingly, in terms of sensitivity analysis, doubling the relative risks (RRe) elasticity from +0.1 to +0.2 (i.e. twice the extent of compensatory smoking previously
modelled) completely wipes out the health gain from a 30% reduction in nicotine content.
If we equate compensation with increased intensity of smoking, this corresponds to an increase in mean cigarettes per day from 12.0 to 14.4 instead of 13.2.

In summary then, removal of ‘excess nicotine’ could have a substantial impact on prevalence but a lesser although still important impact on attributable mortality in the medium to long term – provided that smuggling and compensatory smoking could be severely limited.

Less toxic cigarette scenario

Scenario: 30% reduction in toxicity implemented progressively from 2006 to 2011.
Parameters: Relative risk (RR) current smoking 25% decrease; initiation rate 2.5% increase; and net quit rates 10% decrease.

It is an open question whether a less toxic cigarette could be manufactured, especially with respect to cardiovascular toxicity.

Purely for the purposes of illustration, we will assume that a 30% reduction in overall toxicity is possible, whether through changes to the tobacco, the additives, or other dimensions of cigarette design. 30% has been claimed by some authors to be feasible (e.g. through the use of activated charcoal filters).

We further assume that regulation of marketing will be sufficient to prevent the tobacco companies’ making inflated claims as to the ‘safety’ of the new products.

Tengs et al. (2004a & b) has modelled a ‘less toxic’ scenario using SD modelling and hazard functions are taken from her paper along with other intimations from the literature.

In essence, a 30% reduction in toxicity will not produce a 30% reduction in RR, for at least two reasons:
- some smokers will increase their consumption, or at least not cut down to the extent they might otherwise have done;
- if less toxic product is also less acceptable (e.g. due to differences in taste), some switching to (more toxic) home grown or contraband tobacco will occur.

So we modelled an RR (relative risk) elasticity of –0.8.

The risk with a less toxic cigarette is, of course, expansion of the tobacco market (due to fewer current smokers quitting and more ex-smokers relapsing – and teenagers would also have one less reason not to experiment and initiate).

Benefits at the individual level will not translate into benefit at the population level if prevalence and consumption increases. We call this the ‘reverse prevention paradox’.
Integrated system dynamics: analysis of tobacco control policies in New Zealand

The literature is sparse as to the extent of behavioural effects that might be seen – much will depend on how the ‘less toxic’ tobacco products are marketed. What is clear is that the greater effect will be on quitting rather than initiation. Based on very limited guidance in the literature, we model a quit elasticity of −0.33 and an initiation elasticity of +0.08.

Given major uncertainty about these hazard functions, sensitivity analysis is very important for this scenario.

Table 7: Model output for the less toxic cigarette scenario

<table>
<thead>
<tr>
<th></th>
<th>Prevalence Rate</th>
<th>Prevalence Count</th>
<th>Consumption Pc</th>
<th>Consumption Total</th>
<th>TAM Rate</th>
<th>TAM Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>base</td>
<td>22.3</td>
<td>761</td>
<td>977</td>
<td>3328</td>
<td>124</td>
<td>4921</td>
</tr>
<tr>
<td>expt</td>
<td>22.4</td>
<td>765</td>
<td>981</td>
<td>3342</td>
<td>119</td>
<td>4730</td>
</tr>
<tr>
<td>diff</td>
<td>(0.1)</td>
<td>(4)</td>
<td>(4)</td>
<td>(14)</td>
<td>5</td>
<td>191</td>
</tr>
<tr>
<td>% diff</td>
<td>(0.4)</td>
<td></td>
<td>(0.4)</td>
<td></td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>base</td>
<td>21.6</td>
<td>769</td>
<td>946</td>
<td>3372</td>
<td>120</td>
<td>4963</td>
</tr>
<tr>
<td>expt</td>
<td>22.1</td>
<td>787</td>
<td>968</td>
<td>3450</td>
<td>110</td>
<td>4521</td>
</tr>
<tr>
<td>diff</td>
<td>(0.5)</td>
<td>18</td>
<td>(22)</td>
<td>(78)</td>
<td>10</td>
<td>442</td>
</tr>
<tr>
<td>% diff</td>
<td>(2.3)</td>
<td></td>
<td>(2.3)</td>
<td></td>
<td>8.9</td>
<td></td>
</tr>
<tr>
<td>2031</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>base</td>
<td>21.0</td>
<td>775</td>
<td>920</td>
<td>3400</td>
<td>115</td>
<td>4887</td>
</tr>
<tr>
<td>expt</td>
<td>21.8</td>
<td>805</td>
<td>955</td>
<td>3529</td>
<td>107</td>
<td>4555</td>
</tr>
<tr>
<td>diff</td>
<td>(0.8)</td>
<td>(30)</td>
<td>(35)</td>
<td>(129)</td>
<td>8</td>
<td>332</td>
</tr>
<tr>
<td>% diff</td>
<td>(3.8)</td>
<td></td>
<td>(3.8)</td>
<td></td>
<td>6.8</td>
<td></td>
</tr>
</tbody>
</table>

Even if toxicity could actually be reduced by 30%, and even assuming relatively limited behavioural effects leading to minimal expansion of the tobacco market (2% in 10 years and 4% in 20 years), the impact on attributable mortality is only moderate.

Note that this impact peaks in the medium term (at about 9% greater reduction than the BAU after a decade) then falls back to around 7% after a further decade – although this still amounts to over 300 deaths avoided per year.

Sensitivity analysis around the ‘risk / use equilibrium’ shows that were there no behavioural effects, the health gain would be about 50% greater than shown (i.e. around 10% reduction in attributable mortality in the long term). On the other hand, if behavioural effects are twice as great as shown (i.e. a 5% increase in initiation rates and a 20% decrease in net quit rates) the model estimates that there would be no net population health gain at all.

In summary, the population health benefits of a reduced toxicity cigarette may not be as great as might be naively expected, mainly because of behavioural effects leading to expansion of the tobacco market (increased prevalence and consumption). Nevertheless, a good case can be made that continuing smokers should not be denied access to less hazardous products, provided these can be shown to be genuinely less toxic, and this can be robustly measured and monitored.
Summary of scenarios

Table 8: Summary of scenario assumptions

<table>
<thead>
<tr>
<th></th>
<th>RR</th>
<th>Initiation</th>
<th>Quitting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced affordability</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Reduced addictiveness</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Reduced toxicity</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
</tr>
</tbody>
</table>

The less affordable cigarette scenario involves changes in the three key ‘policy sensitive’ variables that are all in the ‘healthward’ direction. By contrast, this is not so for the less addictive and less toxic scenarios, which turn out to be exact opposites of each other.

Thus the less addictive cigarette increases RR through compensatory over smoking, while the less toxic cigarette directly reduces it. The less addictive cigarette slows the transition from experimentation to ‘hooked on nicotine’ regular use, while a less toxic cigarette gives adolescents one less reason not to smoke.

A less fierce addiction of course makes it easier for current smokers, most of whom would like to quit, to actually do so. While a belief that cigarettes are now less toxic provides the addicted smoker with an excuse not to make the quit attempt.

The interesting question is whether, in a combined scenario, the reduction in addictiveness and the reduction in toxicity will simply cancel each other out, and we will be left with an outcome no different from that achievable via a less affordable cigarette on its own. In which case it would seem not worthwhile to bother with harm reduction strategies at all.

Combined scenario

Scenario: 20% reduction in affordability; 30% reduction in nicotine content; 30% reduction in toxicity from 2006 / progressively 2006/11.

Parameters: RR current smoking 30% decrease; initiation rate 20% decrease; net quit rates 20% increase.

The joint elasticities are derived essentially by summing the separate scenarios, with some modification for plausibility. Since these are not based directly on empirical data, sensitivity analysis is especially important for this scenario. At the same time, it is precisely the ability to simulate such multiple policy enhancements simultaneously that is the strength of the SD approach.
In brief, using the assumptions already discussed, the combined scenario shows much greater benefits than the affordability scenario on its own.

Substantial impacts on attributable mortality and consumption, but not prevalence, are seen with little delay. These increase steadily in the mid term and a substantial effect on prevalence emerges. And in the long term we see reductions of 15% or more in prevalence, consumption and most importantly, attributable mortality.

Summary of results

Table 10. Summary of results - 2031

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Prevalence</th>
<th>Consumption</th>
<th>TAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current (2006)</td>
<td>23.3</td>
<td>1020</td>
<td>4330</td>
</tr>
<tr>
<td>BAU</td>
<td>21.0</td>
<td>775</td>
<td>4890</td>
</tr>
<tr>
<td>Less affordable</td>
<td>19.1</td>
<td>755</td>
<td>4500</td>
</tr>
<tr>
<td>Less addictive</td>
<td>18.2</td>
<td>820</td>
<td>4650</td>
</tr>
<tr>
<td>Less toxic</td>
<td>21.8</td>
<td>955</td>
<td>4550</td>
</tr>
<tr>
<td>Combined</td>
<td>17.9</td>
<td>710</td>
<td>4080</td>
</tr>
</tbody>
</table>

The different scenarios are compared here, using the key indicators in 2031 as the outcome measure.

The combined scenario achieves a prevalence of about 18%, one percentage point lower than the affordability scenario and slightly better than the next best scenario with respect to prevalence i.e. the addictiveness scenario.
The combined scenario also achieves a lower per capita consumption than the affordability scenario could do by itself, at around 700 CE/y. And most importantly, it achieves a 10% lower attributable mortality than the affordability or toxicity scenarios on their own.

The dynamic behaviour of the main variables for each of the 5 scenarios discussed in this paper are summarised in Figure 5. The main performance measures include smoking prevalences, the number of current smokers and the annual mortality figures associated with tobacco smoking in New Zealand. Historical figures are shown for the period from 2001 to 2006, and the scenarios are provided for the period from 2006 to 2031.
Integrated system dynamics: analysis of tobacco control policies in New Zealand

Figure 5: Comparison of scenarios – main performance measures

Scenarios:
1. Business as usual
2. Less affordable cigarette
3. Less addictive cigarette
4. Less toxic cigarette
5. Combined scenario
IMPLEMENTATION AND ORGANISATIONAL LEARNING

A number of different scenarios have been analysed with the system dynamics model developed for tobacco control in New Zealand. However, the model can also be used as the basis for examining a range of other tobacco control scenarios. These include: a Snus scenario (Swedish snuff); a Tobacco Authority (regulated market model) scenario; and a nicotine market regulation scenario.

From the results outlined, it would seem there may be some merit in seriously considering tobacco product modification or harm reduction regulations.

However, the model supports the notions that this would only be the case if compensatory smoking and tobacco market expansion could be severely limited, and if such product regulation was combined both with effective marketing regulation and with sustained tax increases.

Once again, let us emphasise that this modelling has been done for illustrative purposes only. In reality, tobacco product regulation is problematic so long as we lack robust testing methods and full disclosure provisions.

Also, there are some limitations to the tobacco control model as it currently stands. These include:

- The model is age structured but not differentiated by sex, ethnicity or economic/social grouping.
- Demographic trends (fertility, migration) are not fully captured, so population growth is under-estimated.
- Health effects are captured only by mortality, not morbidity.
- Some relevant dimensions of industry behaviour and tobacco control captured only crudely, if at all.

These limitations will be addressed by further development of this model. In the meantime, the system dynamics model is available for stakeholders in New Zealand:

- to provide a joint learning experience with respect to system dynamics modelling and tobacco control;
- to frame policy questions and assess suitability of the model for exploring them; and
- to obtain the necessary empirical data to run the model and agree plausible ranges for sensitivity analysis.

ACKNOWLEDGEMENTS

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**Integrated system dynamics: analysis of tobacco control policies in New Zealand**


BACKSTAGE OF THE GLOBAL CLIMATE CHANGE: A SYSTEM THAT EVERYBODY SEEMS TO THINK THAT IT RELATES TO SOMEONE ELSE

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ABSTRACT

The city of Ushuaia, located at the southern end of the world, is already one of the many regions affected by the severe consequences caused by the Global Climate Change (GCC).

The physical evidence of GCC is shown by the gradual disappearance of the mountain glaciers that surround the city of Ushuaia, and also by others factors such as the increase of mean annual temperature in the area and a substantial decrease in winter rainfall, among others. These factors appear not to bring alert to society about the significant consequences that have derived from this situation in the short and long terms.

Our research group is trying to analyze the socio-economic consequences generated by the disappearance of glaciers around the city of Ushuaia, because they are the main source of drinking water, by using a systems approach.

Thus, we conceptualize the problem by identifying its elements, the description of the relationships between themselves and the distinction of the most relevant subsystems. We were able to establish the conceptual boundaries that distinguish our system from its environment, and the multiple relationships that operate between them.

In the other hand, we have found through these studies a series of emergent properties, which are the result of the analytical perspective we have undertaken; those emergent properties are as important as those ones that were revealed at the beginning of the investigation, including the contamination problem of the glacier water tributaries and their diminishing flow.

We will present in three stages the results that have been found so far: the first stage shows the background related to the effects of the GCC over the Patagonian glaciers, Argentina, and especially those ones that surround the city of Ushuaia, highlighting the projection about their volume; then, we will show the system behavior under analysis and its relationships with the environment, indicate the existing subsystems and describe the idea of horizon of potabilization, which will allow us to lay the foundations for further development of a mathematic model, aiming to predict the moment when the population of Ushuaia will run out of water, at least during the summer months, by considering the current state of variables and
Backstage of the Global Climate Change

relationships. At the end of these presentations, we will arrive at the conclusions achieved at this phase of the investigation.

Key Words: GCC, Global Climate Change, Glaciers disappearance in Ushuaia, Water, Socio-economics consequences, Horizon of potabilization.

INTRODUCTION

The city of Ushuaia, located at the southern end of the world, is already one of the many regions affected by severe consequences caused by the Global Climate Change (GCC).

The physical evidence of GCC is exposed by the gradual vanishing of the glaciers that surround the city of Ushuaia, and also by other factors such as the increase of mean annual or seasonal temperature in the area and substantial decrease in winter rainfall, among others. These factors apparently do not bring alert to society about the significant consequences that may be derived from this situation, both in the short and long terms.

Our research group is trying to analyze the socio-economic consequences generated by the disappearance of glaciers around the city of Ushuaia, because they are the main source of drinking water for the urban population, by using a systemic approach.

We will present in three stages the results that have been found so far: the first stage shows the background related to the effects of GCC over the Patagonian glaciers, Argentina, and especially those ones that surround the city of Ushuaia, highlighting the projection about its volume in the future; then, we will show the system behavior under analysis and its relationships with the environment, indicate the existing subsystems and describe the idea of horizon of potabilization, which will allow us to lay the foundation for further development of a mathematic model, aiming to predict then moment when the population of Ushuaia will run out of water, at least during the summer months, by considering the current state of variables and relationships. At the end of these presentations, we will arrive at the conclusions achieved at this phase of the investigation.

The severe consequences caused by Global Climate Change (GCC) are constantly present in the press and more often well known for most of us.

At the same time, there are studies in which it becomes clear that human irresponsible activity has greatly contributed to reach this state of issues in which there are already irreversible consequences.

Our Patagonian region is no exception to these conditions; on the contrary, the effects turn out evident with an alarming easiness in most cases. And in others, the alarming thing is because of the natural approach with which the situation is taken by the general public and the also by political leaders in particular.

This research group is composed by professors, students and teaching assistants of the degree of Public Accountant of the Faculty of Economics at the National University of Patagonia-San Juan Bosco.

This led us to seek proper tools that would allow us to approach the study of the problem in all its dimensions, for which we thought that the systems approach is appropriate for this purpose.

First, we will present the model of the system that we have defined as our object of study. The model will allow the distinction of the interaction of different
elements and through its relationships, a series of properties that characterize it emerges.

Then we will expose information about the GCC effects on the Patagonian glaciers, Argentina, and especially those that surround the city of Ushuaia, highlighting the projection of their volume.

Subsequently, we analyze the subsystems that are distinguished within the main system, as for example, the "Subsystem Environment-Society", highlighting the environmental consequences of Global Climate Change, which for our study will be treated as available published information. We will focus on the socio economic variables that are related as a result of the temporary loss of freshwater tributaries for the city, highlighting some collateral factors from GCC.

The "Subsystem Drinking Water Demand" and the "Subsystem Supply of Drinking Water" reveal the economic aspects with strong demographic contents, where government policies impact on the web of relations between these two subsystems.

As a result of these analyses, we found that the problem of shortage of drinking water is an issue that is being discussed increasingly among actors of the affected communities, detecting furthermore that these discussions are focused on the symptoms of the problem, and therefore seeking alternative solutions that have not a complete overview of the situation, thus demonstrating linear thinking and short term approach.

**THE SOCIO-ECONOMIC SYSTEM UNDER STUDY**

After a first stage study, we have modeled the problem as a large system with multiple actors, elements and relationships that are jointly participating in accordance with their particular interests; other actors are more concerned about the future of a resource which is essential for human life development, such as drinking water.

We also find groups of individuals that are alien to the problem of the disappearance of glaciers, since this is considered as part of the future in the medium term. These groups of persons are discussing instead problem solving on the short-term, those which require immediate action.

At this stage of the investigation, we want to stress that, given the lack of reliable planning and long term analysis by actors who have the power to make decisions on issues involving the future of the entire city, any problem is transformed over time in a situation of conjuncture, in which they tend only to analyze the manifestations of the problem, leaving aside the study of the causes that generate it.

Thus, considering the objectives of this study, in the socio-economic impact generated by the disappearance of glaciers around the city of Ushuaia, specifically those ones that supply fresh water to the city, we find three interacting subsystems involved, over which we may distinguish important emergent relationships:

- **Subsystem Environment - Society**: this subsystem corresponds to the effects caused by GCC on the glacial mass. These include the emission of greenhouse gases, the increase on mean temperature, the logging of native forests caused by land intruders in the city and changes in the landscape.

- **Subsystem Demand of Drinking Water**: this subsystem analyzes the population increase as a result of internal migration and natural
increase, the factors influencing tourism which in turn produce a seasonal demand, and permanent water supply, among others.

- **Subsystem Supply of Drinking Water:** this subsystem involves the production and distribution of drinking water as a result of purification of raw water that comes from the tributaries that are born in the glaciers, the need to seek for alternative sources when lower flows may take place, investment in infrastructure both for the potabilization process as for water transportation.

The network of complex interrelationships, exposed conceptually in these three subsystems, has social implications and that is why the object of study is highly dynamic, and its evolution presents a significant degree of uncertainty about the status of variables in the future.

The shortage of drinking water is a problem of the whole community of actors involved in the social life of our city, which often lose sight of the scope of consequences that are generated by the development of their daily activities, causing the deepening of the effects that are already evident.

Faced with this complex network, projected on a time horizon of medium and long term, we intend to achieve an overview of analysis, to unravel this web of interactions that crosses the different dimensions of the problems under consideration, including also the context that surrounds it in its web of relationships.

Thus, we present the conceptual model of the system analyzed, in which we distinguish the elements that concern us about the context, the interacting subsystems, and the main consequences of the joint action of all their elements.
Here we can see different information flows like the one formed by climatic variables affecting the glaciers that surround the city of Ushuaia, and which are generating their disappearance, with a consequent impact on freshwater tributaries that are a source of drinking water for the city. We can see here that the routine business of the community, in some cases driven by government policies also affect climate variables, and so the feedback flow restarts.

Arriving at this point, we would like to clarify that the proposed model is provisional, since it is supplemented or modified as we get more information about the problem under study; that is why the model is dynamic.

Each of the subsystems are compose by multiple elements and relationships which are peculiar to themselves, as we will explain in detail below, turning out a complex analysis when more and more details are added to the model.

Our main concern at this time is the final result of "Shortages of Drinking Water", caused by a multiplicity of causes that are all interrelated between themselves. Therefore, we will put emphasis on relations that link the various factors that composes the problem, seeking to stress the patterns of organization that are manifested, which helps us understand the emerging phenomena which take place in the fabric actions and reactions, and to understand relationships and dependencies underlined on the model.

To do so, we will use a graphical of system dynamics, where we can see the interrelationships among the factors involved in all three dimensions analyzed, and its context:
As it can be seen, highlighted in these graphs, research work and literature review allow us to predict that the consequence of the problem under study will take place within a period of 12 to 15 years, with a final consequence which is the glacier disappearance.

The disappearance of the mass of ice will become significant, in terms of water supply, at least, during summer months, when there will be no ice to keep the snow in the landscape and prevent its melting out.

Those factors generating this effect are caused by climate issues that in most cases are exogenous variables to the model proposed in this study, but, however, we will provide a little detail about them. Nevertheless, it should be pointed out that some of the climate variables have been included in the model because they have a direct
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impact on the system studied, even considering that it could be just a minimum impact.

It is also important to note that projections that have predicted on scientific bases the disappearance of glaciers puts beyond our grasp the opportunity to influence the causes of the problem, considering that GCC is part of the global context worldwide, but we should be able to anticipate, administrate and manage its effects.

Considering the "Shortage of Drinking Water" we find a wide range of causes that generate it, both in the "Subsystem Demand of Drinking Water" as in the "Subsystem Supply of Drinking Water", where the fabric of social events that give rise to various self-reinforcing cycles begin to emerge, revealing a portion of the social and economic consequences that will affect the city of Ushuaia.

Those consequences range from impairment of the quality of life of the inhabitants, as the negative effects on economic processes due to the lack of an essential natural resource to human life, up to the lack of interest for future economic investment in the local tourism industry.

In this case, we believe that there are concrete possibilities for action by the community and the State to reverse the effect of the shortage, either operating upon the demand as well on the supply of drinking water, enabling adoption of various strategies to minimize the effects produced by GCC.

An important part of the context is shown in government policies at the three levels of the State (Nation, Province and County), which in most cases are not coordinated on the three subsystems proposed, a fact that introduces a strong component of entropy in the problem. After passing through a brief description of the effects that climate generates on glaciers, we will present the details of each subsystem, showing their relationships and interrelationships describing the delays that have been so far identified.

THE PROBLEM OF GLOBAL CLIMATE CHANGE AND GLACIERS

To give an account of the importance of the effects of GCC in the variables analyzed in this study, we will transcribe the summary of the study by one of us (Jorge Rabassa) on the topic of glacier vanishing. Note that the full version of this paper has been recently published at www.iea.usp.br/iea/artigos/globalchangeinsouthamerica.pdf:

“Global Climate Change (GCC) can be recognized at the global level through rising mean annual or seasonal temperature, rising or diminishing regional precipitation, rising global sea level and a general increase in the frequency and intensity of extreme meteorological events. The impact of GCC has been observed in Patagonia, Tierra del Fuego, and the Antarctic Peninsula, particularly since 1978, when the Andean glaciers started to retreat. These impacts have increased in intensity with time. The cited regions are characterized by their high vulnerability, derived from their location in the Southern Hemisphere, their extreme climates, and high intrinsic climatic variability. Their geographical location with respect to the southern oceans and the Antarctic Circum-Polar Current is also very relevant to this problem. The variations have been particularly relevant to mankind during the Late Pleistocene (120 to 15 thousand radiocarbon years ago [\(^{14}\text{C}\) ka B.P.]), the Late Glacial (15-10 \(^{14}\text{C}\) ka B.P.), and all through the Holocene (the last 10 \(^{14}\text{C}\) ka B.P.) until present times.

The impact of GCC may be both socially and economically harmful and beneficial in human terms, both socially and economically, depending on the different
geographical areas involved or the kind of human activities considered. For example, among the beneficial impacts of GCC for South America is the displacement of the southern areas toward more benign climates and the southwestward widening of the agricultural frontier in the Argentine Pampas. However, the negative impacts are clearer and stronger, such as loss of biodiversity and forest mass, degradation of ecotonal fringes, higher frequency of extreme hydrological events such as flooding and drought, reducing or disappearing permafrost conditions in the Andean ranges above the tree line, drying of wetland and peatland ecosystems, rising climatic snowline, and fast recession of mountain glaciers and snowfields, among many others.

In the case of Patagonia and the Antarctic Peninsula, this has forced a general recession of most of the Patagonian and Fuegian glaciers, mainly due to loss of accumulation area, rising temperatures at the glacier snout elevation, and increase of ice calving in lakes or the sea. The famous Perito Moreno Glacier (Parque Nacional Glaciares, province of Santa Cruz, southernmost Patagonia [and probably its Chilean counterpart neighbor Pio XI Glacier as well (Rivera and Cassassa, 1999)]) is a very particular case, because it keeps advancing actively year after year, blocking Brazo Rico, a branch of Lago Argentino, generating an ice wall that later collapses when the accumulated water pressure in the southern side of the wall exceeds the ice resistance. When the wall breaks, it is a stunning event, which is greatly appreciated by tourists and naturalists from all over the world who come in large numbers to see this event, which occurs not every year. This anomalous behavior is most likely not related to climatic factors, but to internal, glaciological forcing, or to recurrent, small magnitude seismic events, though large enough to induce glacier sliding.

The Upsala Glacier, the largest in Argentina and one the biggest in South America and the Southern Hemisphere outside of Antarctica, is undergoing a clear, catastrophic recession both in its front and thickness.

A similar destiny is threatening most of the smaller, mountain glaciers and discharge ice tongues from the surviving ice sheets in Patagonia and Tierra del Fuego: the Northern Patagonian Ice Sheet, Southern Patagonian Ice Sheet, Darwin Cordillera Ice Sheet and some other smaller ice caps in the Magellanic Archipelago. On the Argentine side of the Isla Grande de Tierra del Fuego, the Alpine glaciers of the Fuegian Andes are in sharp, violent retreat. See, for example, the photographs corresponding to the Martial Glacier and the Alvear Este Glacier. Most likely, around the year 2020 A.D., most of these glaciers will have vanished, generating a priceless loss of pristine environments, water resources, alpine wetlands, scenic and tourism resources, as well as their natural, scientific and cultural legacy. The Lower Cone of the Castaño Overo Glacier was the topic of a graduate thesis in Geography (see Bertani et al., 1986; Fig. 16 and 17), but it has already vanished as a permanent ice body, due to intense summer melting. Thus, in only 20 years, a focus of scientific, geographical and glaciological studies is lost forever.

The Patagonian and Fuegian glaciers have probably existed and survived continuously for at least the last 100,000 years, since the beginning of the last glaciation. However, they have been gravely injured by man-induced climate change in the last 200 years, since the “Little Ice Age”*. Their fading will generate enormous damage and economic loss to Patagonian tourism activities, which are today partially dependent upon their survival and perpetuation.

In other regions of Argentina, such as the central Argentine Andes, and particularly the irrigated vineyards of the Cuyo piedmont areas, and in other parts of the World as well (Central Chile; Sierra Nevada de Santa Marta, Colombia [Rabassa et al., 1993]; Tibet; Eastern Africa, etc.), seasonal melting of glaciers and snowfields
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has an intense contribution to agricultural irrigation or they provide fresh water resources in settled areas. For example, the city of Ushuaia, Tierra del Fuego, the southernmost city in the World, is fully reliant upon glacier melt water for fresh water supply. Also, the glaciers of the Glaciares National Park of Southern Argentina have been acknowledged as a World Mankind Heritage Site in the UNESCO program, purportedly an enduring, everlasting, perpetual recognition. Amazingly, mankind itself has doomed them in a very short time, probably before full scientific research can be accomplished.

The impact of GCC on the Antarctic Peninsula truly deserves a special comment. As a consequence of higher temperatures, the ice barriers or ice-shelves of the Weddell Sea in the eastern side of the Antarctic Peninsula have partially collapsed in recent years (and for the first time at least in 100,000 years) calving colossal icebergs named “ice islands”, that are tens of km long and thousands of square km in size. Oceanographic studies show that the Larsen-B ice shelf had not experienced a history of full recession and reformation at least since the Last Glacial Maximum.

Ice barriers, such as the Larsen Ice Shelf, would probably be incapable of regeneration in foreseeable times. In the Antarctic Peninsula, the climatic, regional snow line has also risen, predominantly along its western coast as much as 100 m to 200 m during the last 15-20 years. This is clearly verified by the occurrence of recently exposed bedrock surfaces, which have been ice covered at least since the Last Glacial Maximum, around 25,000 years ago. These expanding exposed rocky areas at or near sea level during the Austral summer have forced a large expansion of the areas for colonization by penguins and other marine birds. This fact will positively stimulate an increase in their populations, probable migrations, and other ecological consequences difficult to forecast.

A steady decline during the last decades of the thickness and a lowering of the frozen surface under permafrost conditions, and a consequent expansion of its active layer (the seasonally ice free upper portion of the soil) would generate serious structural problems in high mountain building and roads, general increase of superficial runoff, and probably an increase in frequency and intensity of mass movement catastrophic events.

Finally, the northward shift of the Antarctic Circumpolar Current as a result of GCC could cause oceanographic, climatic and ecological impacts unpredictable at the southern tip of South America.

It has long been known that the impacts of GCC will be larger in regions of higher latitude; Patagonia, Tierra del Fuego and the Antarctic Peninsula are excellent examples of this, and sad and silent testimonies of environmental damage caused by human stupidity.”

SUBSYSTEM ENVIRONMENT - SOCIETY: A STAGE ON CRITIC SUSTAINABILITY

In the report "Our Common Future", better known as the Brundtland Report, sustainability is defined as:

"Ability to meet the needs of the present without compromising the ability of future generations to meet their own needs”

When we consider the network of relationships involved in the addressed problem, the system analysis gives us an uncertain vision as well, but also highly critic considering sustainability. The climate factors determine the possibility of glacier preservation. In the particular case of the area near the city of Ushuaia,
systems approach has allowed us to recognize that these glaciers are exposed to a scene of extraordinary dynamic conditions due to the participation of both social and climatic factors, which are displayed in the chart below:

The graph above represents the dynamic relationships of the Subsystem Environment - Society, in which it is possible to recognize the impact of the factors that are related to the average temperature increase (a clear signal of GCC) that causes the gradual disappearance of our glaciers: on one hand, the greenhouse gases and secondly, the logging of native forests. We know that both factors are generated by human activity in its most varied expressions, but the second one responds to a phenomenon of significant importance in the social aspect of the system under study: the Intruders on State lands (people who occupy lands belonging to the State), whose devastating effects on the ecosystem require immediate attention by the town government through government policies that allow human settlements with the least ecological impact, not only to prevent the immediate change of scenery product of logging but also to avoid the imminent disappearance of permanent ice.

There are scientific studies that are monitoring the behavior of the main glaciers of the Island of Tierra del Fuego considering the impact of climate change,
such as the Martial Glacier—the largest source of drinking water in the city of Ushuaia, and its conclusions are disturbing. According to a study by the Southern Center for Scientific Research (CADIC-CONICET) (Strelin & Iturraspe, 2007) the Martial Glacier has lost 70 hectares of glacier ice in the last hundred years, being the most dramatic setback for the period 1970-2000, because the glacier lost only 26 hectares of its original area between the years 1898 and 1970. From 1970 onwards, it has lost 44 hectares of ice. Currently, the glacier occupies approximately only 23 hectares, a truly very small size that does not warrant sustainability.

The projections provided by these scientists agree with the conclusions of Rabassa (2006) concerning its imminent vanishing, based on similar models and reduction indicators that allowed this author and his colleagues to predict already in 1986 the collapse of Castaño Overo Glacier (Nahuel Huapi National Park, Patagonia, Argentina), a disappearance that took place in the 90’s.

**SUBSYSTEM DEMAND FOR DRINKING WATER: A DYNAMIC NETWORK OF COMPLEX SOCIAL EVENTS WHICH WE MUST UNRAVEL AND REARRANGE USING SYSTEMS ANALYSIS, TRYING TO REDUCE COMPLEXITY**

In the situation described above, the other two subsystems which will complement the analysis of the problem of drinking water in the city of Ushuaia should be added.

As we have stated earlier, these two subsystems are the “Subsystem Demand for Drinking Water” and the “Subsystem Supply of Drinking Water” which, as we have noted, constantly interact within a complex network of elements.

It is important to distinguish our approach in studying the relationships between the systemic dimensions of these sub-systems and their environment, as a prerequisite to address the complexity involved in analysis.

In the introduction to the study of the demographic characteristics of demand of drinking water, it is important to analyze the factors that typify the population of Ushuaia, either from the vision of the individual behaviour when they settle in the city, indicators of population and growth prospects in the short and medium term. These parameters should be able to measure the current and future demand of water.

Given the characteristics of the subsystem that we are addressing we decided to categorize the demand into two groups, whose differential behaviour will allow us to explain the composition of aggregate consumption.

**THE STABLE WATER DEMAND**

Firstly, we must emphasize that the population of the city of Ushuaia has maintained since the last four decades a positive growth rate: +70% from 1960 to 1970; +102% in the 1970’s; +157% from 1980 to 1990; +57% from 1990 to 2001. These are data provided by the National Institute of Statistics and Census (INDEC/Argentina). The city has currently about 65,000 inhabitants and the growth projection made by INDEC estimates a population increase of about 3% cumulative annual until 2015, based on the people registered in 2001, which amounted to 45,785 persons. This estimation was made based on assumptions regarding a regular demographic growth; thus, it can be altered in the future depending on other variables not considered in the past.
Rising population in the city responds to two demographic phenomena which are determining the “Stable Demand”, being this understood as the one that should be supplied throughout all the year because it is a permanent demand. The first demographic phenomenon is the natural increase (difference between births and deaths per period); the second, with greatest impact on population, is the process of internal migration which responds to a large extent to a type of combined events within economic and social factors. This event comprises some government policies on the one hand, impacting positively on the location of productive business in the area by encouraging a favourable economic environment and an active labour market; on the other, by satisfying the demands of new urbanizations generated by the own population growth.

The establishment and development of business companies in the province of Tierra del Fuego is covered by National Law No. 19,640 (an economic government policy), which created taxes and customs exemption for those factories that are located in the province, all this in order to promote economic growth in the island. Enterprises and factories are not intensive water consumers, but they become a strong pole of attraction work, constituting another factor that encourages the establishment of permanent residents in the area.

In this first study of some relationships at a large scale, we can say that the category “Stable Water Demand”, defined within the larger concept “Demand for Drinking Water”, is determined by two demographic phenomena (internal migration and natural increase) and an economic phenomenon (company location), which correspond to an event of combined economic-social conditions, defined by government policies that are carried on in the city.

THE SEASONAL DEMAND OF DRINKING WATER

The second category is known as “Seasonal demand”, which represents the amount of potable water which is consumed during the summer season of the year as a result of the large tourism influx between the months of October to April.

The tourist attraction provided by the natural beauty surrounding the city has allowed a significant development in tourism services, as well as highly profitable hotel and gastronomic business. This fact, coupled with a government policy that maintains a favourable exchange rate on local currency, attracts great groups of tourists from around the world, thus transforming the port of Ushuaia in the last stop for large ships after going on to Antarctica. Landing in Ushuaia Port provides them food supply and, mainly, drinking water to complete their itineraries.

The latest data published by the Ministry of Tourism of the Town of Ushuaia revealed that the total visitors during 2007 was 251,827, which include all the cruise passenger and arrivals by means of other means of transportation, projecting for 2015 a total incoming of 319,751 people.

Despite the fact that tourism activity takes place during most of the year, the bulk of operating income is in the southern hemisphere spring and summer months, generating this specific “seasonal demand” of drinking water.

On the other hand, it is important to note that the total revenue generated from tourism during 2007 (according to the same source cited above) was $ 288,164,724, being projected for 2015 for the same concepts the amount of $ 558,714,177.

The latter reference is very important to highlight one of the effects that create shortage of drinking water, as it is the declining in economic activity, that next stages of this work will quantify.
THE SUBSYSTEM DEMAND OF DRINKING WATER

Previously, we were able to distinguish the major relationships that allow us to understand how they interact with social and economic phenomena in determining the aggregate total demand for water, defined by stable demand and seasonal demand. To view them integrated, we have rescued from the original graph (Water Shortages and its Dynamic Relationships) the factors of the Subsystem Demand of drinking water, which interact as follows:

To measure in physical terms the current need of water we have taken as a reference, on one hand, data published by the last census, and on the other hand, calculating the rate of consumption of drinking water – or average consumption determined by the ratio between the total amount of purified water and the total population of the city in an annual period.

Actually, supplying water to the entire population requires making drinkable between 600 to 700 liters per inhabitant, per day. This indicator is among the highest in the country, if we consider that, for example, in the Province of Buenos Aires the average consumption is 300 liters per capita per day, according to data published by the Company Buenos Aires S.A., who is responsible for making water drinkable. Moreover, the city of Santa Fe consumed 450 litres per capita per day, whereas in Cordoba, this indicator amounts to an average of 500 litres. The World Health Organization (WHO) advised as optimal consumption per person the amount of around 250 litres per day, being the essential minimum individual requirement of 60 litres per day.

By comparison, for example in Spain, rates are still significantly lower than in our country: in Barcelona one inhabitant consumes an average of 119 litres per day, in Seville 137 litres per day and in Madrid 124 litres per day.
The apparent excess of consumption that is recorded in the city of Ushuaia in relation to its actual population may be due to many causes that are not discussed in this paper. However, we believe that there is an immediate connection between this situation and the volume of distribution of purified water, because certain inefficiencies in the supply have been observed that do not necessarily represent real consumption. To explain this relationship, we will continue discussing the Water Supply Subsystem.

**SUBSYSTEM SUPPLY OF DRINKING WATER**

The supply of drinking water in the city of Ushuaia starts with a purification process of the water that comes from tributaries fed by melting glaciers. The main problem that will be generated after the disappearance of these ice masses due to permanent impact of GCC is the immediate seasonal reduction that will be verified concerning the actual flow of these tributaries, and consequently a reduction in the amount of water available to be purified. This situation is more obvious during the summer months of the year, because the melting of the glacier is the result of the accumulation of snow during the winter, and insofar as the size of the glacier is reduced, the amount is conditional water from melting that feeds the tributaries to a lesser extent.

If we isolate this natural behaviour of the system responding to a natural cycle of climatic factors exogenous to the system, we find that there is a variable in determination of the offer that is endogenous and of a paramount importance: the loss of drinking water mainly during the distribution process. The losses are the result of poor maintenance of supply networks which should be attended by the Government (water service provider), so we understand that government policies should be implemented towards improving operational distribution and loss reduction. However, the preventive maintenance of the network is not enough, because in some areas of the city a total replacement of networks is needed because of their deteriorating standard, or also due to the need to increase the volume of distribution in response to growing demand from the new urban settlements. Even this last factor -analyzed within the stable demand for drinking water- is already generating the need for the installation of new water treatment plants. All this, maintenance, replacement, laying of new networks and new treatment plants are all part of government policies carried out by means of increased investment in infrastructure, which is directly linked to water production.

Ushuaia faces, then, a multiple problem considering the standpoint of the supply which we are analysing: the main problem is the imminent demise of its primary source of drinking water under the impact generated by GCC, in short to medium terms and, incidentally, to a poor management of treated water during her distribution, whose effects begin to be gradually regarded as most significant while the resource becomes increasingly scarce.

Whereas the disappearance of glaciers will generate a seasonal shortage in the summer, the search for alternative sources of water is one of the strategies developed in conjunction with the comprehensive study of more efficient distribution, as both factors imply an economic cost that should be socially minimized.

The approach previously developed allows us to visualize the relationship of the emerging problem of drinking water in the following chart:
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RELATIONSHIPS WITH DELAYED EFFECT

Like any social system in the complex web of relationships involved, effects that occur in many cases are transformed into causes of post effects, and so on.

In this case, in addition to this sequence of events, adding the factor of "delays" of some effects. We consider as “delay” the time between the moment in which it shows a causal relationship, and the time of collecting the impact caused by it.

It is important to recognize the existence of delays throughout the system, while their identification, will allow us to characterize the system in a more complete manner.

The next step, if we aim to perform simulations with the model proposed, is temporarily quantify these delays, which will allow us to analyze the evolution of the variables involved in a more representative study of the problem.

We will describe a case of delay for each one of the subsystems presented here:
Changes in the landscape caused by intruders of state lands, especially those located up in the mountains, require a time of perception by the community since precarious housing was initially set with the objective of moving unnoticed until the time comes for taking a more stable possession of the land, which is achieved through a simultaneous settlement of several families. Subsequently, the settlement intruders begin to extend their houses which involve the down cutting of native forests. This can be later added to the urbanization sector, which produces even greater logging.

Investment in hotel business involves the construction of infrastructure, which previously required the formulation of the project, obtaining permits and financing. This period of time may vary depending on the size of the project and climatic factors affecting the process of building, which in the city of Ushuaia are very important and demanding. Thus, since it starts from the investment up to the effective growth of tourism, there is a deadline which is considered a delay.
The search for alternative sources of fresh water requires the mobilization of the entire state system, because it is responsible for providing the service of drinking water in the city of Ushuaia.

So far, the State did not consider the socio-economic consequences that may take place when a possible shortage of drinking water starts in the future. By saying this, we stress that the time required for heavily regulated start-up procedures should be added to the studies to be carried out (there is academic research that is being devoted to the problem).

**CYCLES OF SELF-REINFORCING**

In any system there are relationships that cause disruption of its operation, thereby producing a destabilization that threatens the livelihood of the system itself.

In turn, if a series of disturbances relate to one another, increasing the effects produced in each cycle closes at the same place had its beginning, causing the feedback to himself, and generating a "cycle of self-reinforcing".

The cycle of self-reinforcing or positive feedback loop, amplifies the effects of destabilization caused by the system, and that is why we are paying special attention to those taking place in our system of interest.

It should also be remembered that much negative feedback loops (also known as regulators) as the positive ones are elements of endogenous generation system, we mean that the disturbance may have originated outside of it, but the regulation process or amplification takes place within the system.

Thus, we have chosen to develop a cycle of self-reinforcing that integrates the three major subsystems and that studied the consequences of which are expected to predict its evolution.

The analysis begins with the "Government Policies" that both the national and provincial state have carried out in the past, to promote "establishment of factories" in Tierra del Fuego. Originally, these policies were aimed at achieving internal migration from the rest of the country to the island, and populate a territory that was threatening to get lost because of the borders conflicts.

Over time, "Government Policies" seeking a "Increasing Population", remained until today, stressing that they have been effective, since the rate of population growth in the province has been one of the highest the country over the past decades.

The steady increase in population in the city, generates a steady growth of the emission of "greenhouse gases" in developing the daily lives of individuals, gases that
are added those issued by the rest of the planet, thus generating the "average temperature increase", showing the first effect that led to this investigation: the "Disappearance of the Glaciers" surrounding the city of Ushuaia.

Until this point, it has been revealed five positive relationships in the loop that we are describing, adding to them the "Reducing the flow of Tributaries" that borned from the melting glacial ice.

The reduction in the flows impact directly and without any delay in "Water shortage" in our city, second effect which will cause the socio-economic consequences that we are studying.

To this are added the influence generated by the "Increased Demand Stable" in the consumption of drinking water, as the effect of increasing population, thus presenting a scenario where supply is hampered to increase infrastructure, and be able to respond to demand increase.

The needs of "new urbanizations", claimed by population growth, are affected by shortages of drinking water because the municipality does not authorize the urbanizations private or public, if they do not account with this service which is considered vital to decent living conditions of people.

Thus, we come again to the need to generate more "Government Policies", which on the one hand achieve the goal originally proposed, and on the other hand, the ultimate impact occurred, undermined that objective.
CONCLUSION

The disappearance of glaciers around the city of Ushuaia, is a circumstance almost irreversible because the main factor that produces it is increasing the average temperature of our planet, and the actions that might be taken to change those facts should be at global level.

In this way, and with a forecast of disappearance of those glaciers by 2020, in our community will occur in the future a number of consequences that we aspire to predict in time and magnitude of its effects, and also to find tools that allow us manage these important changing relationships that will occur in the daily lives of the inhabitants of the city of Ushuaia.

The consumption of potable water will continue to grow as the population increases, both by internal migration as for vegetative growth, what we called "the stable demand", the same thing happens with tourist activity, for which significant increases are projected for this activity, forming part of the "seasonal demand".

The purification of potable water is closely linked with the evolution of glacial masses, that is why in critical months of higher temperatures, January and February, will decline the flows of tributaries will continue until the drought of them in the same period.

The quality of life of city dwellers will seen diminished, as well as the economic activity in it.

The problem of shortage of drinking water is already a topic of discussion at the moment that manifests itself in intermittently, but for most actors, the solution of the problem is presented as a matter of state investment in new distribution networks and water treatment plants, without considering that the greatest risk lies in the lack of raw water for the purification and distribution of it.

In our study, have emerged important relationships and properties of the system to provide a more complete vision of the whole, allowing predicts some of the causes and its effects. If we had based on a linear vision we would not have seen the whole picture.

The GCC generates a multiplicity of purposes, which are part of the ambience of the system studied here.

Moreover the system has feedback loops which seek to stabilize or amplify the effects of changes in the environment, and is to meet such information where we want to go with our work.

The lack of basic information to project the development of the variables, have led us to incorporate a new stage in the research work, as is the design of indicators that we consider critical to the system, such as: the "Index of intruders" of state land in our city,"Levels of contamination of Tributaries "and the volume of economic activities that make intensive use of drinking water.

Parallel to this fieldwork, we will start with the generation of mathematical models that will help us to project the impacts that we already have found until here, under a systemic perspective, with greater precision timing and magnitude.

With this research it stem the potential for determining the limit turning point, where investment in the search for concrete solutions to the problem of shortages, is equal to the losses caused to society by the lack of action.

They also emerge as possibilities for action, not just the management of material resources at stake, but also the integration of the community to tackle the problem and propose cultural change on water consumption and the treatment of the environment, changes that require long deadline for consolidation.
Backstage of the Global Climate Change

Part of this complex plot that we have achieved unravel, finding the way in various aspects that lead us back to the beginning of analysis, but no longer the very beginning, a new, enriched, which opens new perspectives proponents rethink the bases of our work, and our research will be developed under this perspective of emergent relations and dynamics interrelationships.

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