INFORMATION ECOLOGY AND KNOWLEDGE MANAGEMENT

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Summary

The traditional view of organizational systems and supporting information and knowledge systems is based on the model of a well-oiled machine expected to deliver optimum performance derived from pre-defined parameters and specifications. Such systems consider performance as a derivative of external controls defined by the designers of the systems and have given marginal importance to the self-adaptive and emergent nature of human and organizational systems. These characteristics of human and organizational systems are particularly relevant to their adaptation and survival within dynamically changing business environments. Recently, some management thinkers have attempted to address the human bases of information systems within the framework of information ecology. This characterization, although interesting, needs to be further developed to account for the human sense-making processes and self-regulatory nature of the natural ecosystems relevant to new organizational environments. We extend the information ecology framework to a framework of knowledge ecology. The knowledge ecology of organizational systems goes beyond the emphasis on information, to account for action, performance and adaptation of self-regulatory systems.

1. Introduction

The author's quest for the knowledge ecology of organizational systems was motivated by his dissatisfaction with the prevailing paradigm of information systems. The problem doesn't seem only with the prevailing technology-based paradigm of information systems but also with related control systems and performance systems. The paradigm of information systems developed around optimization-driven focus on efficiencies was adequate for the industrial era. However, the new business environments have exposed serious limitations in the traditional logic underlying development, design and performance of information systems. Such limitations are often reified in the increasing failure of sophisticated information systems to deliver up to expectations, and the large-scale implementation failures of information systems that cannot keep up with the radical and discontinuous pace of change in the organizational environment.

The information ecology is an organization's information environment, and consists of the numerous interacting and interdependent social, cultural, and political subsystems that shape the creation, flow and use of information in the organization. Thus an organization's information ecology influences what information is produced and stored, what information is made available and to whom, and what information is required and valued in task performance. The framework of information ecology attempts to emphasize people rather than technology within networked information and communication systems. The key proponents of information ecology have made an interesting case for focusing on information rather than on the hardware, software and telecommunication networks.

However, for relating information to action, performance and adaptation, we need to extend the information ecology framework to relate the "information-centric" networks to "action-centric" networks of knowledge ecology. In addition, the proposed framework of knowledge ecology suggests that some of the prescriptions of information ecology framework need to be refined for application in hyperturbulent organizational environments characterized by radical and discontinuous change. These environments are characteristic of the new forms of organizations that represent a departure from the traditional models of organizations based on agency theory models of humans motivated primarily by punishments and rewards. Based on the model of self-control in contrast to the traditional emphasis on external control mechanisms, the proposed framework is better aligned with what Chris Argyris has termed "the current revolution in management theory." The knowledge ecology framework proposed in this article seems more relevant to performance embedded in dynamically evolving informal and formal relationships that defy clear demarcations in terms of traditional concepts of organizations and industries. Examples of such entities include free agents, business ecosystems, and virtual communities of practice.

2. From Information Ecology to Knowledge Ecology

2.1. Information Ecology Revisited

The key premise of *information ecology*, defined as "the complete information environment," is that organizations need to focus beyond the "machine-engineering" focus on the technologies of information. The complete information environment addresses "all of a firm's values and beliefs about information (culture); how people actually use information and what they do with it (behavior and work processes); the pitfalls that can interfere with information sharing (politics); and what information systems are already in place (yes, finally, technology)." The proponents of information ecology have criticized the information-processing model of organizational information systems for its following simplistic assumptions:

- information is easily stored on computers – as "data";

- modeling computer database is the only way to master information complexity;
- information must be common throughout an organization;
- technology change will improve the information environment.

Instead of a narrow focus on technology, information ecology puts how people create, distribute, understand and use information at its center by supporting the following beliefs:

- information is not easily stored on computers – is not "data";
- the more complex an information model, the less useful it will be;
- information can take on many meanings in an organization;
- technology is only one component of the information environment and often not the right way to create change.

Information ecology recognizes that humans endow information with relevance and purpose and acknowledges that human involvement increases as we move along the continuum of data-information-knowledge. However, information ecology doesn't explicitly account for the dynamically changing organizational environment that is often characterized as a "world of re-everything". The new organizational environment requires richer understanding of human sense-making processes that relate knowledge to action and performance. Furthermore, with its emphasis on traditional logic of external controls, such as performance incentives and bonuses, information ecology needs to be extended to grasp the concept of emergent behavior that is often a characteristic of self-adaptive systems. Self-regulation is the hallmark of intrinsic motivators and self-control that are essential for realizing true human involvement in endowing information with relevance and purpose, and most importantly in converting knowledge into action and performance. Hence, despite recognizing the distinction between data and information, information ecology falls short of accounting for the link between information and performance, particularly in the case of new organizational environments. The following discussion elaborates upon each of these issues and provides the bases for the contributions made by the proposed framework of knowledge ecology.

2.2. New Organizational Environments and Information Ecology

Information ecology assumes a relatively stable and predictable environment as the basis for mapping all the attributes of that environment. However, a review of literature on environmental change presents a more interesting picture. Three decades earlier, system theorists such as Emery and Tryst had noted that the environmental contexts in which organizations exist are themselves changing under the impact of technological change -- at an ever-increasing rate, and toward ever-increasing complexity. Developing on their work, other system theorists, such as Shirley Terreberry, had concluded that an increasing number of organizations find themselves in environments in which accelerating rate and complexity of interactive effects exceed their capacities for prediction. She suggested that organizational change was increasingly externally induced and organizational adaptability was increasingly a function of the ability to learn and to perform according to changing environmental contingencies. Organizational change is generally described as a response to the increasing environmental complexity and environmental turbulence. Existing literature on organizational change management distinguishes between two kinds of environmental change in terms of *incremental change* versus *discontinuous change* and *continuous change* versus *discontinuous change*. While *environmental complexity* is a function of the numerosity, diversity and interdependence of other entities in the organization's environment, *environmental turbulence* is a consequence of the decreasing cycle-time of the individual events [such as new product introduction, customer response, etc.]. It has been suggested that the levels of both environmental complexity and turbulence, as well as their absolute rates of growth, will be significantly greater in the future than in the past. Hence, future environmental change is expected to be more rapid and more *discontinuous* in nature. Moreover, this change is anticipated to be of an ongoing and continual nature. The desired organizational response to

such environmental changes will be increasingly of an *anticipatory* nature and less of a *reactive* nature. Members of such organizations would need to be "effective anticipators" who can carry out the mandate of a faster cycle of knowledge-creation and action based on new knowledge.

In contrast, information ecology assumes a relatively predictable environment in its pre-specification of the utility of information and the consequent actions and performance. Such assumptions are embedded in the proponents' assertions such as: "the cost of having the *wrong* information – or not using the *right* information – is difficult to measure" and "decisions made based on *useless* information have cost companies billions of dollars" [italics added for emphasis]. The dynamic and discontinuous change characterizing the new organizational environments makes pre-specification of any information in terms of "right information," "wrong information" or "useless information" dubious. When *core competencies* of yesterday may become *core rigidities* of tomorrow, the best practices embedded in the "right information" may act as blinders for organizations and restrain questioning of prevailing assumptions related to status quo.

Knowledge ecology contributes beyond the extant understanding of information ecology in two important aspects – first, by realizing the dynamically changing nature of organizational environments that constrain optimization-oriented, efficiency-seeking, logic of mainstream information systems; and, second, by proposing how better understanding of self-control in human sense-making processes can better relate the human meaning-making activity with actions and performance outcomes.

2.3. Knowledge Ecology for the Era of Discontinuous Change

Some of the key premises underlying the notion of knowledge ecology may be extrapolated based upon observations of the natural ecosystems. How these characteristics relate to the changing organizational environments is explained in the subsequent discussion.

- Knowledge ecology primarily focuses on social networks of individuals in contrast to the *overly* technological emphasis of traditional knowledge management systems on computers and information technology networks.
- Within knowledge ecology, focus on people does not *only* imply understanding of knowledge exchanges and relationships based on such exchanges. It also implies understanding of how such knowledge influences action or potential for action based on such exchanges.
- Just as natural ecologies thrive based on species diversity, knowledge ecology thrives on diversity of knowledge. Such diversity rests on cooperative competition: the various knowledge nodes collaborate *as well as* compete based on their differentiating characteristics.
- In a knowledge ecology environment impacted by sudden and pervasive change, mode of survival is adaptation [or more accurately, "anticipation of surprise"] instead of optimization.
- Knowledge ecology is made up of knowledge nodes and knowledge exchanges and knowledge flows. In knowledge ecology, the basis for cooperation and survival is differentiation *and* similarity between the knowledge nodes. Highly differentiated knowledge nodes can collaborate to accomplish specific actions and may dissolve thereafter. However, collaboration between such nodes would require that they be able to "relate" to one another under an overarching mission or theme.

Knowledge ecology treats knowledge creation as a dynamic evolutionary process in which knowledge gets created and recreated in various contexts and at various points of time. More detailed distinction between knowledge ecology and information ecology is presented in the following section. The supporting rationale suggests that knowledge ecology framework provides a more robust basis for designing knowledge management systems conducive to the new organizational environments.

2.4. Beyond Information Ecology to Knowledge Ecology

The notion of knowledge ecology shares its emphasis on information management with information ecology. However, it goes beyond this concept to underscore the more important issues of knowledge creation and knowledge renewal, and resulting action and performance. The emphasis of knowledge ecology, as apparent, is on creation of new knowledge and renewal of existing knowledge. In addition, this perspective lays primary emphasis on action and performance based on knowledge, as without action and performance, the issue of information is quite *meaningless*. In addition, knowledge ecology, as explained in this article, advances general understanding of human self-controls as they relate to information processing and human sense-making and performance. Finally, it highlights the model of *loose-tight systems* that encourage simultaneous learning and unlearning for coupling the optimization and efficiency-seeking processes with human sense-making processes that can facilitate deconstruction of assumptions that may be left unchallenged otherwise.

The framework of knowledge ecology shares its emphasis on changing information ecologies and need for designing flexible systems. However, it differs from information ecology that prescribes: "if we can't anticipate the future, we shouldn't plan it in detail," by treating diversity of perspectives as necessary for generating multiple views of the unpredictable future. Such appreciation of diversity of perspectives, similar to what was deployed by the Royal Dutch Shell strategic planning chief Arie de Gaus, is essential for creating the interpretive flexibility necessary for learning, unlearning and adaptation required by the radical pace of discontinuous change. Another key assertion of the information ecology framework is that: "it makes much more sense to focus on describing [the available information and information processes relevant to] *today*" rather than defining information and information processes for tomorrow. In comparison, knowledge ecology explicitly takes into consideration a future characterized by discontinuous shifts and innovative breakthroughs that may turn today's assumptions on their head. In contrast to the information ecology framework that has its focus on today's status quo, the proposed knowledge ecology framework thus takes a more proactive approach by visioning the opportunities and threats inherent in today and mapping multiple courses of the future. The flexibility of vision of tomorrow inherent in the knowledge ecology framework makes it a more dynamic and adaptive model for thriving on discontinuous and radical pace of change. In contrast to the information ecology framework, it considers "multiplicity of information sources" not as a liability but as an asset for defining multiple views of a future that doesn't compute.

3. Philosophical Bases of Organizational Knowledge Ecology

3.1. Philosophical Bases of Knowledge Ecology

The model of information ecology is suitable for predictable environment characterized by incremental change. However, such conceptualizations, based upon heuristics -- embedded in procedure manuals, mathematical models or programmed logic -- capture the preferred solutions to the given repertoire of organization's problems. Mason and Mitroff noted that such systems have: "implicitly assumed...a well-structured problem, a data or model basis, an operational control-hierarchical authority organizational context and an impersonalistic [sic] computer printout mode of presentation."

Following Churchman, they observed that such systems are best suited for:

(a) "well-structured problem situations for which there exists a strong *consensual* position on the nature of the problem situation," and,

(b) "well-structured problems for which there exists an analytic formulation with a solution."

Type (a) systems are known as Lockean systems and type (b) systems are known as Leibnitzian systems. Current conceptualization of organizational knowledge repositories is motivated by projected efficiencies that would follow from [almost] impassive acceptance of institutionalized and archived "best practices." Based primarily upon the above consensus-building models, such knowledge

repositories tend to institutionalize the *status quo*. Organizational routines that were originally embedded in the standard operating procedures and policies, practices, rules and norms become embedded in the "shared" knowledge databases in the form of "best practices." For instance as observed by Hedberg and associates: "Formalized information systems tend to be mechanistic and inflexible, and they incorporate assumptions that their designers have already identified the organizational and environmental properties deserving attention."

As evident, the information ecology perspective is based primarily upon a Lockean and Leibnitzian logic of consensus building, representing an extension of the decades-old predisposition of information systems designers for Leibnitzian and Lockean inquiry systems.

However, such *consensus building* systems are generally capable of providing "only one view of the problem," and hence are not very suitable for discontinuously changing environments. Dynamic environments not only require multiple perspectives of solutions to a given problem, but also diverse interpretations of the problem based upon multiple views of the future.

Following Churchman, there are two other kinds of inquiry systems that are more conducive to ill-structured environments. Kantian systems attempt to give multiple *explicit* views of "complementary" nature and are best suited for "moderate" ill-structured problems. In contrast, Hegelian systems provide multiple "*completely antithetical*" representations that are characterized by "intense conflict" because of the contrary underlying assumptions and are best suited for "wickedly" ill-structured problem domains.

The proposed model of knowledge management is based upon Kantian and Hegelian systems to facilitate multiple interpretations of archived "best practices." This divergence-oriented process would ensure that the best practices and their underpinning assumptions are subjected to continual re-examination and modification.

3.2. Myths Underlying Current Knowledge Management Systems

The preceding discussion, about the changing organizational environment and the increasing relevance of divergent meanings of information, underscores some myths that underlie current design of organizational knowledge management systems. Technology gurus, as well as hardware and software vendors, have been offering "out-of-box solutions" that are expected to enable knowledge management. Such off-the-shelf solutions are expected to offer means for storing best practices devised by human experts in information databases. These databases, in turn, may be later used for crunching out *pre-determined* solutions based on *pre-defined* parameters. The convergent and consensus building emphasis of such systems may be adequate for stable and predictable organizational environments. However, such systems -- based primarily on rules and procedures embedded in technology -- seem misaligned with the dynamically changing business environment.

Knowledge ecology framework addresses some such myths about the design and efficacy of organizational knowledge management systems.

Myth 1: Knowledge management technologies can deliver the right information to the right person at the right time. This idea applies to an outdated organizational model. Information systems in the old industrial model mirror the notion that businesses will change incrementally in an inherently stable market, and executives can foresee change by examining the past. The new organizational environment, however, is marked by radical, not incremental, change. Organizations can't plan long-term; instead, they must shift to a more flexible "anticipation-of-surprise" model. Thus, it's impossible to build a system that predicts who the right person at the right time even is, let alone what constitutes the right information.

Myth 2: Knowledge management technologies can store human intelligence and experience. Technologies such as databases and groupware applications store bits and pixels of data, but they can't store the rich schemas that people possess for making sense of data bits. Moreover, information is

context-sensitive. The same assemblage of data can evoke different responses from different people. Even the same assemblage of data when reviewed by the same person at a different time or in a different context could evoke differing response in terms of decision-making and action. Hence, storing a static and explicit representation of a person's tacit knowledge -- assuming one has the willingness and the ability to part with it – is not tantamount to storing human intelligence and experience.

Myth 3: Knowledge management technologies can distribute human intelligence. Again, this assumes that organizations can predict the right information to distribute and the right people to distribute it to. However, bypassing the distribution issue by compiling a central repository of data for people to access doesn't solve the problem. The fact that information is archived in a database doesn't ensure that people will necessarily see or use the information. Most of our knowledge management technology concentrates on efficiency and creating a consensus-oriented view. The data archived in technological "knowledge repositories" is rational, static and without context and such systems do not account for *renewal of existing knowledge* and *creation of new knowledge*.

A key contribution of the proposed model of knowledge ecology is developing a richer and more complete understanding of *sense-making* bases that are only cursorily accounted for by the *information ecology* framework. The sense-making bases help us understand the linkage of information processing to action and performance and also the appreciation of the diversity of meaning and action that may result from the same information.

4. Accounting for Human Action and Performance

4.1. Sense-Making Bases of Human Action and Performance

To understand how information gets translated into knowledge, and, more importantly, into action and performance, we need to reflect upon the processes that underlie human sense-making leading to action [or inaction] and performance. Understanding of human sense-making processes helps one develop a better appreciation of the link between information and actions underlying performance. It also helps us understand the current disconnect between performance designed into the information systems and the resulting performance of such systems when they are appropriated by human users. Knowing the human sense-making bases is critical for correct understanding of how information processed through various information systems appropriated by human users translates into knowledge and resulting action and performance. In absence of such understanding, design of organizational knowledge systems would be guided by relatively simplistic assumptions of information ecology. Hence, a richer understanding of human sense-making underpinning translation of information into action and performance constitutes an important issue.

Three perspectives of human sense-making related to action and performance are pertinent to the knowledge ecology framework proposed in this article. These three perspectives have been used earlier to explain individual information-seeking behavior in the information search process and the transformation of external controls into self-controls at the level of individual IS users. An overview of these perspectives is given in the following discussion; this overview is then used to build an integrative framework for understanding the human sense-making processes that underlie action and performance.

As observed by scholars of human psychology such as Bruner, in the computational metaphor: "information is indifferent with respect to the message...[it] comprises an already precoded message...meaning is preassigned to messages." From this perspective, there is no role for the human mind in constructing meaning out of such information. Most definitions of "information" in this paradigm are devoid of any explicit reference to the "meaningfulness" of information at the individual or social level. However, such definitions ignore the relational character of information as physical

messages do not by themselves have meaning. It is only through the interpretation of a receiver that they are taken to convey a certain meaning. The relevance of the social context is important, yet the role of the individual in attributing that social context with any meaning [instead of ignoring it as "random noise"] is at least equally important. When the individual interacts with characters scrawled in a specific format or with pixels arranged in a specific manner, the meaning is assigned depending upon the existing cognitive links available at the individual's disposal. These meanings would not exist "if human beings would not have created the objects and entities" in them. Something would make sense only if it can be related or connected to some existing link. Or as observed by John Dewey, "To grasp the meaning of a thing, an event, or a situation is to see it in its *relations* to other things..." Individual "sense" is a cognitive construction that is imposed upon the facts the better to organize understanding -- *sense is not intrinsic in the reality, but is constructed by the individual*. The private aspect of these actors gets translated into the public aspect of the enacted environment through the process of individual sense-making -- a process characterized by the interaction of affect, cognition and action. The various individual constructions *together* create a *perception of* social construction within a certain social context. The individual process of construction is very much related to the individual's information-seeking process.

4.2. Individual Construction of Meaning in Information-Seeking

The process of information-seeking starts with the state of uncertainty -- which might increase if the new information is not coherent with the existing mental model or system of constructs. The initial stage of construction during the information-seeking process is generally marked by "confusion, doubt, frustration, and threat" as the individual tries to resolve the differences between the new experiences and the existing system of constructs.

The process of learning entails interaction between the individual's existing system of constructs and newer experiences. New experiences are interpreted with reference to the existing system of constructs, which, in turn, is modified by newer experiences. As observed by Carol Kuhltahu: "When a person is involved in a dynamic process of becoming informed, relevance does not remain static...What is relevant at the beginning...may later turn out to be irrelevant, and vice versa...The individual is actively involved in finding meaning that fits in with what he or she already knows, which is not necessarily the same answer for all, but sense-making within a personal frame of reference."

The *syntactic* dimension of information, which has been the primary focus of information theory, is nothing but a carrier of semantic and pragmatic dimensions. The *semantic* dimension is the individual's interpretation of the syntactic dimension based upon one's existing system of constructs; it represents the *personal* meaning ascribed to information. The *pragmatic* dimension translates personal interpretation of information into the actualization of a specific behavior or action. This process is moderated by the interaction of the individual rational and affective characteristics.

Studies in information-seeking behavior have suggested that the information search process is characterized by the interaction of the individual's affective (feelings), cognitive (thoughts) and physical (actions) attributes. In the early stages of the information search process, vague and unclear perception of the information-seeking task results in the individuals' demonstration of uncertainty, confusion and frustration. Such symptoms diminish as individuals gain better understanding of the process and thus demonstrate increased confidence and certainty. Or as observed by Kuhlthau:

> Uncertainty due to a lack of understanding, a gap in meaning, a limited construct initiates the process of information seeking. Uncertainty is a cognitive state that commonly causes affective symptoms of anxiety and lack of confidence. Uncertainty and anxiety can be expected in the early stages of the Information Search Process. The affective symptoms of uncertainty,

> confusion and frustration are associated with vague, unclear thoughts about [a given information-related task].

This section provides a theoretical perspective for the proposed model by relating the individual perspective of meaning to the constructivist theory of learning. The two primary themes of this theory are: (i) individuals construct their own unique personal worlds; (ii) this construction involves the total person "incorporating thinking, feeling, and acting in a dynamic process of learning." This constructivist view of individual interpretation is based upon existing theoretical foundations of the constructivist theory of learning.

4.3. Dewey's Individual Construction of Meaning in Reflective Thinking and Action

John Dewey observed that in terms of "reflective thinking", learning occurs through a combined process of acting and reflecting. Reflective thinking seeks connections between the actions and their consequences to achieve an understanding that is generalizable to other situations: "the power to retain in one's experience something which is of value in coping with the difficulties in a later situation." According to Dewey, reflective thinking involves five "phases" or "aspects": Suggestion, Intellectualization, Guiding Idea or Hypothesis, Reasoning, and Test of the Hypothesis by Action. In all five phases, the individual plays an active role in the process of converting facts or data into action.

> "Mere facts or data are dead" unless given some interpretation by the individual. Faced with a situation, the "pre-reflective" state, which is characterized by perplexity or confusion, sets the problem to be solved. In the Suggestion phase, the "mind leaps forward to a possible solution." Direct or overt action is restrained. Instead, an idea or suggestion, which is "a vicarious or anticipatory way of acting", is generated. The pros and cons of various suggestions are analyzed in terms of "purpose and its conditions, its resources, aids, and difficulties and obstacles." Intellectualization phase involves translation of what is initially an "*emotional* quality" or "annoyance" of the situation into a precise conceptualization of the problem from the observed conditions. In the Hypothesis phase, the suggestion is converted into a more definite supposition or a hypothesis by analyzing the problem with respect to the suggestions. The Reasoning phase depends upon existing knowledge and involves elaboration of suggestions into consequences and their rejection or acceptance. Reasoning suggests the possible consequences of acting on each idea. The final phase of Testing by Action involves overt action to provide "verification of the conjectural idea.
>
> The five phases may occur in any order and may telescope into each other. The five phases of reflective thinking are outlined in Table 1.

Thus, learning, as viewed by Dewey, is an active individual process involving action and reflection. George Kelly's Personal Construct theory provides an alternative psychological interpretation of Dewey's philosophical perspective.

4.4. George Kelly's Personal Construct Theory and Individual Construction of Meaning

The fundamental postulate of the Personal Construct Theory is that constructs are created from an individual's experience in order to anticipate future events: "a person's processes are psychologically channelized by ways in which he [or she] anticipates [future] events." This fundamental postulate suggests the model of a "human as scientist" -- who tries to make sense of the world and tests that sense in terms of its predictive capacity. Individuals use constructs to make sense of the world and anticipate events by "construing their replications" -- by erecting constructs of similarity and contrast

for the various elements that are construed. Kelly uses the analogy of listening to music to describe this process of replication -- he emphasizes that replication is something that emerges from the interpretation of the individual. Kelly describes individual construction as a series of choices based on prediction of the outcome or results: "a person chooses that which will extend and define the system." The process of construction, which is highly individualized and based on one's existing system of personal constructs, is aimed at finding meaning and making sense of the situations.

Since constructs are specific to individuals, in the constructivist view, unlike the behaviorist perspective, behavior is highly individualized. Contradicting the stimulus-response connection suggested by behaviorist psychology, Kelly suggests that humans respond to "*what they interpret the stimulus to be*" which is a function of the constructs one detects or imposes upon one's world. It is possible for two persons who are involved in the same events to experience them differently because they construe them differently. Furthermore, because they construe the events differently, they will anticipate them differently and will behave differently based upon those anticipations. Individuals adjust their constructs better to match the environment *to improve predictions of their actions*: "all of our present interpretations of the universe are subject to revision or replacement...there are always some alternative constructions available to choose among in dealing with the world." Based upon the unfolding events, the individual validates one's [initial] assumptions and revises them in case they do not match the expected outcomes.

In this view, the individuals differ from each other not only in the events that they seek to anticipate, but also in their individual approaches to the anticipation of the same events. The individuals differ in respect of how they perceive or interpret a situation, what they consider important about it and what they consider its implications to be: "Each of us lives in what is ultimately a unique world, because it is uniquely interpreted and thereby uniquely experienced."

Although, there are individual differences in the construction of events, yet sharing of experiences among persons could occur "through construing the experiences of [one's] neighbors along with [one's] own [experience]". In case the persons are guided by different cultural identifications or personal considerations, they may exist in the same reality "but in altogether different subjective worlds". However, there may be some shared (common) aspect among the two individuals about which they may construe similarly i.e. "discriminate, interpret, see the implications of events, in similar ways": "They are similar in so far as, and with respect to, events which have the same meaning for them". To that extent of commonality of the construction of experience, the psychological processes may be construed as similar between the two persons.

To play a role in the social process involving another individual, one needs effectively to construe the construction process of another. It does not imply that the two persons' construction processes should be similar -- it only implies that the individual's construct system gives one a meaningful understanding of the other's construct system. This does not "make role a purely social construct, that is, see it as the acting out of a dialogue written for the two persons by the society in which they [are]". Rather, individual reality is tuned to the socially accepted interpretation and this process of the individual's adjustments of his / her constructs may entail considerable anxiety and unrest.

The Personal Construct Theory (PCT) gives explicit recognition to the individual as a whole: comprising *both* rational *and* affective dimensions. According, to Kelly: "The reader may have noted that in talking about experience I have been careful not to use either of the terms, "emotional" or "affective". I have been equally careful not to invoke the notion of "cognition". The classic distinction which separates the two constructs has become, in the manner of most classic distinctions that once were useful, a barrier to sensitive, psychological inquiry".

According to PCT, the individual experiences certain predominant feelings during each phase of constructing new information into an individualized system of personal constructs. On encountering an unfamiliar concept, the individual's system of constructs is unable to incorporate it and the individual feels confused and perplexed: "almost everything new starts in some moment of confusion". The

prospect of the unknown may have a threatening effect on the individual. The individual may choose to reject the idea in this phase which is characterized as: "the threshold between confusion and certainty, between anxiety and boredom...[when] we are most tempted to turn back". Or else, the individual may choose to formulate a hypothesis that can enable one to break through this moment of threat to get on with the task of testing to confirm or reject the hypothesis. The last phase of this "cycle of sense-making" involves assessing the result of the action and using that information to reconstruct or to assimilate the new construct into the existing system of constructs.

The primary emphasis of this theory is upon the individual's active role in the meaning construction process motivated by anticipation of future events. On encountering a new situation, the individual may feel uncertain, anxious and confused, and may formulate a hypothesis or a "plan of action" to reduce uncertainty and anxiety. The hypothesis is translated into action and the results are compared with initial anticipations. One person's construction may not be the same as that of other individuals even when faced with the same reality.

The process of individual construction (outlined in Table 1) may not necessarily rely completely upon the received information. Jerome Bruner emphasizes the human ability to go beyond the given information to create a personal meaning in order to make better predictions for action.

4.5. Jerome Bruner's Contemporary Perspective of Individual Interpretive Construction

The interpretive task of "going beyond the information given" is central to Jerome Bruner's constructive process. The interpretive task, which is highly personal and based on prior constructs, enables individuals to go beyond the given information to create something individually unique. Bruner's interpretation utilizes the concept of "schema": "that integrated, organized representation of past behavior and experience which guides individuals in reconstructing previously encountered material which enables people to go beyond evidence, to fill in gaps, to extrapolate."

The interpretive nature of individual construction is the key element of this perspective: one must "*suspend disbelief*"...in order to construct "multiple perspectives and possible worlds..." The constructive nature of thinking underlying schema theory treats individuals as actively involved in sense-making. This perspective considers the individual as "one who actively selects information, forms ... hypotheses and on occasion distorts the input in the service of reducing surprise and of attaining [understanding]".

Bruner used the concepts of uniqueness and redundancy of information to suggest the unequal treatment of all new information by the individual. He suggested that the individual's abilities of recognizing similar patterns, inference and categorization allowed one to go "beyond the information given" by using probability and prediction. There is an ongoing tension between uniqueness and redundancy of information that is experienced by the individual as the balance between anxiety and boredom. While uniqueness, within certain limits, keeps the human system on the alert, too much familiarity may lead to monotony. While excessive uniqueness may cause uncertainty and anxiety, too much redundancy may result in disinterest and boredom. Feelings play a critical role in motivating and directing learning. Bruner's interpretative process of construction is outlined in Table 1.

In fact, Bruner criticizes the existing conceptual split between the constructs of thought, action and emotion. To him the three represent an integrated whole: "Emotion is not usefully isolated from the knowledge of the situation that arouses it. Cognition is not a form of pure knowing to which emotion is added ... [and] action is a final common path based on what one knows and feels. The three constitute a unified whole...To isolate each is like studying the planes of a crystal separately, losing sight of the crystal that gives them being".

He further suggests the importance of these linkages for the individual constructions of reality: "linkages between emotion, arousal, drive on the one side and learning, problem-solving, thinking on the other". Most studies in the social construction of technology have focused primarily on the rational

or cognitive "plane." By proposing an integrative model that takes a holistic view of affect, cognition and action, this paper attempts to bring the "unified whole" into perspective.
The three representations of constructivist learning underlying human action and performance are delineated in Table 1.

Table 1: Personal Constructivist Learning: The Three Perspectives

In summary, the constructivist learning theories view transformation of information into human action and performance as an active, engaging process driven by feelings interacting with thoughts and actions. Affective experience plays a key role in guiding cognition and action throughout the construction process.
The above discussion, about the sense-making bases of human action and performance, contributes beyond information ecology's prescription about the managing and controlling of meanings that are attributed to information. For instance, Davenport and Prusak observed: "But ultimately, there are times when multiple information meanings must be managed and controlled." In the knowledge ecology view, this assertion is questionable. Further, the sense-making bases of human action and performance explained above also inform the simplistic assumptions about the policing of human sense-making processes prescribed by the information ecology framework: "[The organization] must also be prepared not only to define common information, but to maintain it by monitoring and policing its use across the organization." These observations are important given the earlier discussion about the increasing importance of divergence of meanings [characteristic of the Hegelian and Kantian inquiry systems] necessary for navigating the fog of unknowingness within wicked environments characterized by the discontinuous and radical pace of change.
The human sense-making behavior underlying action and performance needs to be further informed by the self-regulatory nature of human beings. In essence, diverging from the assertions of information ecology, knowledge ecology emphasizes the transient nature of rewards and performance incentives while suggesting the primary importance of self-regulation, self-control and intrinsic motivation.

4.6. Self-Control Bases of Human Action and Performance

The information ecology framework asserts that external controls, in the form of extrinsic rewards and punishments, are effective for managing individual organizational members' information-sharing behavior. For instance, the information ecology view asserts that: "providing incentives to "do the right thing" – or at least to make it hard (or stupid) to do the wrong thing – is the most effective approach… If firms were truly managing information behavior, they'd have well understood, clearly articulated incentives – for example, promotions, raises, even simple pats on the back – for behaving in the desired way."
Such depiction of human behavior is challenged by knowledge ecology as it has been challenged in some other observations. For instance, Wanda Orlikowski observes that: "Discussions of organization control often tend to downplay the extent to which individuals retain the potential to act to change a particular situation or form of control." In the same line, Anthony Giddens, made his observations about the *dialectic of control*, as a result of which those being controlled may end up controlling the behavior of the controllers: "All forms of dependence offer some resources whereby those who are subordinate can influence the activities of their superiors."
The knowledge ecology framework emphasizes the self-referential nature of human behavior, action and performance. For instance, it relates to the observation of Manz and Sims: "Organizational standards will not significantly influence employee behavior if they are not accepted. Similarly organizational rewards will not produce their desired effects if they are not valued by the employees receiving the rewards. Regardless of how employees' performance is appraised, the performance

evaluation that will carry most weight will be the evaluations that employees make of themselves".

The proposed framework, in essence suggests that, for external controls to be effective influences on members' organizational behavior, these controls must operate as "self-controls," the controls people exert over their own behaviors. The norms embodied in the external controls must be "either directly or indirectly...internalized by the members of the enterprise and operate as personal controls over attitudes and behavior". Incidentally, the self-referential nature of controls is consistent with the constructivist learning viewpoints discussed earlier.

The primary distinction that needs to be drawn here is between the consequences of the control being either *compliance* or *commitment*. *Compliance* implies the conformity of the controllee who is motivated by a desire of a reward or avoidance of punishment and generally lasts only until the promise or threat of sanction exists. Control attempts that seek passive acceptance from employees may be best for achieving compliance. However, as noted by Manz and associates, for achieving commitment there is a need for influence attempts that seek active involvement or "proactive self-control."

In contrast to compliance, *commitment* involves "internalization of management-derived and sanctioned beliefs, norms and values, in the sense that they become part of the core of the individual's perceptual world". This is consistent with the view that control over employees is ultimately self-imposed, and that external controls are likely to lead only to minimal compliance unless they are designed to seek proactive self-control. Self-management denotes control through encouraging the achievement of commitment through "proactive self-control". This approach is based on the premise that control can be exercised only through intrinsic individual motivation and the role of external influences is to facilitate the creation of appropriate self-controls.

Under conditions of self-control, if a certain behavior is motivated intrinsically, the individual will engage in that behavior for intrinsic rewards. The transition from traditional external control mechanisms to the paradigm of self-control is "the current revolution in management theory", according to Chris Argyris. Studies conducted on this concept have suggested that the degree of psychological success or failure has a positive influence on the amount of psychological energy people have available for a given task.

By asserting its faith in "reinforcing the right kind of information-sharing behavior," the information ecology framework reifies the traditional stimulus-response model of controlling human behavior. By overemphasizing external control for achieving pre-specified outcomes, it underplays the necessary interpretive flexibility that is necessary for effectively responding to radical and discontinuous change: "The ultimate goal of managing information behavior, of course, is to create a positive information culture – one where it's simply the norm to "do the right information thing."

In contrast, the self-control model that is characteristic of knowledge ecology defines the role of the external influences as "management of meaning." Instead of pre-specification of outcomes, it emphasizes sharing of vision wherein leadership lies in large part in generating a point of reference, against which a feeling of organization and directions can *emerge*. Effectiveness of the managers in such scenarios lies in leading others to lead themselves through facilitation of subordinates' self-observation, self-evaluation, and self-reinforcement. From subordinates' perspective, Sims and Lorenzi define this process [of self-management] as "the set of strategies a person uses to influence him- or herself." Emphasizing the capability of the subordinates for self-management, Manz and Sims suggest that employees should manage their own behaviors by setting personal standards, evaluate their performance in terms of these standards, and self-administer consequences based on their own self-evaluations. In this perspective, control results from the individual's interaction with "both external and self-imposed process components".

In sum, the knowledge ecology framework integrates the elements of self-adaptation, self-regulation and self-control that are missing from the information ecology viewpoint. By doing so, the proposed framework provides a better understanding of the link between information, knowledge and consequent human behavior that is missing in information ecology.

5. Discussion

Knowledge management solutions characterized by memorization of "best practices" tend to define the assumptions that are embedded in information databases. Interestingly, such embedded assumptions also get *programmed* in the organization's strategy, reward systems and resource allocation systems. The hardwiring of such assumptions in organizational knowledge bases may lead to perceptual insensitivity of the organization to the changing environment. Institutionalization of "best practices" may facilitate efficient handling of routine, "linear," and predictable situations during stable or incrementally changing environments. However, when this change is radical and discontinuous, there is a persistent need for continuous examination and renewal of the basic premises underlying the "best practices" stored in organizational knowledge bases.

The extant knowledge management systems are largely devoid of such capabilities needed for continuous learning *and* unlearning processes mandated by an increasing pace of discontinuous and radical change. Such processes of ongoing knowledge creation are needed for organizational survival. The new organizational world of *permanent white-waters* demands precognition and adaptation in contrast to the traditional emphasis on optimization based on prediction. It is a world in which organizational theories of business need to be continuously re-examined for their alignment with the dynamically changing external reality. This new world of organizations is characterized by "re-everything" involving continuous redefinition of organizational goals, purposes, and the tried and trusted "ways in which things have been done." The radical and discontinuous change of the new business environment overwhelms the traditional organizational response of predicting and reacting based on pre-programmed heuristics. Instead, it demands what may be characterized as "anticipation of surprise." The following observation by Steve Kerr, the Chief Learning Officer of one of the largest US multinationals, would perhaps provide some appreciation of this viewpoint: "The future is moving so quickly that you can't anticipate it...We have put a tremendous emphasis on quick response instead of planning. We will continue to be surprised, but we won't be surprised that we are surprised. We will anticipate the surprise."

5.1. Toward "Loose-Tight" Knowledge Management Systems

The information ecology framework contributes to a more human understanding of information technology and information systems; however, it does not account for the new world of organizations or how human organizational systems can adapt to this world. The knowledge ecology framework discussed in this article fills this critical void. By drawing upon the strengths of both convergence-driven [Lockean-Leibnitzian] systems and divergence-oriented [Hegelian-Kantian] systems, the proposed model offers a combination of flexibility and agility while ensuring efficiencies of the current technology architecture. Such systems are *loose* in the sense that they allow for continuous re-examination of the assumptions underlying best practices and reinterpretation of this information. Such systems are *tight* in the sense that they also allow for efficiencies based on propagation and dissemination of the best practices.

The knowledge management systems based on the proposed model do not completely ignore the notion of "best practices" per se but consider the continuous construction and reconstruction of such practices as a dynamic and ongoing process. As noted elsewhere by the author, such "loose-tight knowledge management systems" would need to provide not only for identification and dissemination of best practices, but also for continuous re-examination of such practices. Specifically, they would also need to include a simultaneous process that continuously examines the best practices for their currency given the changing assumptions about the business environment. Such systems would need to contain *both* learning and unlearning processes. These *simultaneous* processes are needed for assuring the efficiency-oriented optimization based on the current best practices *while* ensuring that such

practices are continuously re-examined for their currency. Continuously challenging the current "company way", such systems are expected to prevent the core capabilities of yesterday from becoming core rigidities of tomorrow.

The traditional technology-oriented knowledge management solutions have adequately served the predictable world paradigm based on the pre-defined models and assumptions. The new era of permanent organizational white-waters, however, requires a knowledge ecology that can facilitate the development and sustenance of the *loose-tight* knowledge management systems described above.

Figure 1: Loose-Tight Model of Knowledge Management Systems

5.2. From Information to Actionable Knowledge

The traditional view of knowledge management has treated knowledge in terms of prepackaged or taken-for-granted interpretation of information, often residing in technological databases. However, this static and acontextual view of knowledge works against the generation of multiple and contradictory viewpoints that are necessary for meeting the challenge posed by wicked environments. As illustrated by case studies of companies that have relied on this concept of knowledge, it may even hamper the organizational learning and adaptive capabilities. The wicked environment of the new world of organizations imposes the need for variety and complexity of the interpretations of information. Such interpretations are necessary for deciphering the multiple worldviews of the uncertain and unpredictable future. A more proactive involvement of human imagination and creativity can perhaps facilitate greater internal diversity [of the organization] that can match the variety and complexity of the wicked environment. The active meaning-making role of human actors thus occupies a prominent role in the subjective and constructive knowledge processes of the knowledge ecology.

Information residing in the organizational knowledge bases, procedures, routines and archives -- in the form of pixels, bits or symbols -- needs to be distinguished from the constructive and dynamic view of knowledge discussed above. Churchman, in his classic treatise *The Design of Inquiring Systems*, noted that: "To conceive of knowledge as a collection of information seems to rob the concept of all of its life... Knowledge resides in the user and not in the collection." On a related note, Nonaka and Takeuchi have emphasized that only human beings can take the central role in knowledge creation. He has asserted that computers are merely tools, however great their information-processing capabilities may be.

As discussed in this paper, the increasingly wicked nature of the organizational environment requires a richer understanding of subjective human sense-making interpretations. Such human sense-making processes can provide the multiple, diverse, and contradictory interpretations based on information in computer databases. As observed more than two decades ago by Chris Argyris, such processes would facilitate generative learning that emphasizes continuous experimentation and feedback in an ongoing examination of the way organizations go about defining and solving problems. He argued that the massive technology of various information and control systems is designed for single loop learning. Unfortunately, trouble arises when the technology is not effective and when the underlying objectives and policies must be questioned. Left unquestioned and unexamined, the organization's theories of business [embedded in the organizational information and control systems] get out of alignment with the changing reality of the business environment.

The above argument suggests that the role of human sense-making processes in organizational knowledge management is crucial for sustaining organizational effectiveness. At least it seems relevant until the technological systems can become capable of generating not only convergent and consensus-oriented solutions, but also diverse interpretations of information despite previously unpredicted contexts and unforeseen assumptions. The knowledge ecology framework discussed in this paper advances the understanding of knowledge management from that of an *information-processing*

paradigm to that of a *sense-making* paradigm. Details about this transition are discussed more completely in the author's book *Knowledge Management and Virtual Organizations*. It provides a more complete understanding of knowledge management that makes sense for organizational survival and competence in the new business environments: "Knowledge management caters to the critical issues of organizational adaptation, survival, and competence in face of increasingly discontinuous environmental change. Essentially, it embodies organizational processes that seek synergistic combination of data and information-processing capacity of information technologies, and the creative and innovative capacity of human beings."

5.3. Toward Communities of Knowledge Intrapreneurs

Drucker is often credited with coining the term "knowledge workers" to characterize the model of organization members in the post-industrial era. The self-referential nature of human action and performance discussed in this article, together with increasing possibility of "anytime, anywhere" definitions of work and organizations, suggest that it is time to rethink this definition. With the changing definition of employment contract in worldwide organizations, one observes that, increasingly, organization members would need to take charge of their own learning, adaptation and "reality check" responsibilities for adding value to the larger set of systems within which they function. More than 15 years ago, organizations such as 3M gave the charge of innovating and creating new products and services to the grassroots employees: this phenomenon was often defined as *intrapreneurship*: entrepreneurship, within the bounds of the organization. With increasingly fuzzy boundaries of organizations and industries, humans are getting used to thinking about work – inside or outside the bounds of formal organizations – in terms of self-control and self-regulation of "what they do", "where they do", "how they do" and "why they do"? Hence, the term that seems more accurately to define the new kind of "knowledge work" is *knowledge intrapreneurship*. Specifically, regardless of the industry or organization an individual is working in, he or she is expected to act more and more as an internal entrepreneur, or *intrapreneur*. Given the increasing relevance of the knowledge value chain in the organizational business processes, one can anticipate that most individuals in knowledge-based organizations would need to perform as *knowledge intrapreneurs*. The term "knowledge intrapreneur" seems more appropriate in this context than "knowledge worker" given the redefinition of organizations and redefinition of work. The new work roles demand that every worker act largely as his / her own manager as well as an entrepreneur in the organizational knowledge-creation process. Such knowledge intrapreneurs are expected to contribute to the organizational knowledge-creation processes by developing knowledge relationships and knowledge exchanges within *and* outside the formal boundaries of the organizations. The emerging archetypes of free agents, virtual communities of practice, and virtual organizations are harbingers of this vision.

6. Conclusions

One can anticipate that the new paradigm of knowledge creation and dissemination would have implications for most types of knowledge work with which we are currently familiar. The paradigm shift is anticipated to have implications for traditional channels of knowledge creation and dissemination. It is also anticipated to facilitate the democratization of policy-making processes that influence specific groups and communities. One cannot discount the importance of technology access and utilization for the individuals, groups, organizations and communities who participate in the knowledge creation and dissemination processes, and are also impacted by such processes. However, the future developments in knowledge management systems have to take into consideration two key issues. First, they need to be based on an integrated understanding of technological design of such systems *and* deep knowledge of how such systems are appropriated by the adopters. Second, they need to be based on an integrated understanding of the information storage, archival and dissemination

processes *and* knowledge of how such information is translated into action and performance by the users.

It is anticipated that a balance between the technological and human elements of future knowledge management systems would facilitate both learning and unlearning processes. This balance is anticipated to result in systems that facilitate "anticipation of surprise" demanded by the permanent organizational white-waters of the new world of business. The resulting *loose-tight knowledge management systems* would balance the emphasis on optimization-based *efficiency* with the double-loop generative learning needed for long-term *effectiveness*. Such systems are anticipated to address more explicitly the proposed notion of knowledge ecology that takes into consideration context, synergy and trust necessary for translating information into actionable knowledge. Such systems would also address the long-term and ongoing knowledge creation needs of the organizations served by knowledge intrapreneurs.

Glossary

individual sense-making: an interjection of effect, cognition, and action with information, which yields a construction of the information, which is different from that of the original raw data. It is a form of social construction of reality.

information ecology: the total informational environment of an organization, consisting of the numerous interacting and interdependent social, cultural and political subsystems that shape the creation, flow, and use of information in the organization. The emphasis is on people rather than technology and centers on how they create, distribute, understand and use information.

knowledge ecology: a focus on the social networks of people in an organization context, and the interactive and interconnective exchanges and relationships, as well as collaborations. Their value is maximized by the diversity of the participants and thereby treats knowledge-creation as a dynamic, evolutionary process, which emphasizes self-adaptation, self-regulation, and self-control.

knowledge intrapreneurship: a knowledge worker who is able to think both inside and outside of the "organizational box", and is characterized as a self-directed, organizational knowledge creator.

loose-tight knowledge management systems: organizational knowledge management systems which have a balanced perspective between optimization-based efficiency and double-looped generative learning needed for longer-term effectiveness.

self-adaptive systems: spontaneous, self-generating occurrence of a pattern or structure from an orderless or differentially configured pattern into a new form and /or critical state. Learning motivates the process.

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Biographical Sketch

Dr. Yogesh Malhotra has contributed to knowledge management and strategic innovation policies and strategies of Intel, British Telecom (UK), Ziff Davis, Hewlett Packard, Arthur Andersen, South Korean technology companies, Government of Netherlands, U.S. Federal Government, and, Government of Mexico in advisory and visionary roles. He has taught on the faculty of Executive MBA programmes at the Kellogg School of Management at Northwestern University and the Graduate School of Industrial Administration at the Carnegie Mellon University and currently holds a professorial appointment at the Syracuse University. He is the author and editor of two critically acclaimed books and several influential research journals and articles on knowledge management, e-business, and strategic innovation. He has served on advisory, editorial and review boards of the National Science Foundation, the Conference Board, Knowledge Management Consortium International, the Academy of Management, IBM Research, Association of Computing Machinery, American Management Association, Association for Information Systems, Harvard Business School Publishing, Institute of Electrical and Electronics Engineers, and, Ziff Davis Standard for Internet Commerce. His interviews and analyses and reviews of his award-winning e-learning and knowledge management ventures have appeared in Business Week, Wall Street Journal, Fortune, Fast Company, Business 2.0, CIO Magazine, Computerworld, Information Week, KM World and hundreds of other TV, print and media channels around the world. As a global thought leader on Knowledge Management and E-Business, he has delivered recent invited keynotes to CIOs in Government of Mexico, hi-tech entrepreneurs and professionals network based in Silicon Valley, Baldrige Quality Award winning U.S. corporations, and global corporate executives at most prestigious industry conferences. He is the founding Chairman and Chief Knowledge Architect of the BRINT Institute, the New York based research, advisory, and e-learning company internationally recognized as a pioneer of leading edge research, practice, and thought leadership on Knowledge Management and Strategic Innovation.