Toward an Actionable Framework of Knowledge Synthesis in the Pursuit of Learning Organization

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Abstract

This paper investigates the idea of knowledge work appropriate to the context of organization transformation. Specifically, we describe an actionable framework of knowledge synthesis, which accommodates the shift of information system (IS) support from automating to informating to knowledging. Our discussion intends to clarify the ideal of a learning organization which is designed to help transfer learning from individuals to a group, provide for organizational renewal, keep an open attitude to the outside world, and support a commitment to knowledge. The paper deals with the classification of knowledge tasks and its relation to organizational design. We elaborate the issue of knowledge characterizations that help structure and facilitate knowledge interconnectivity, through the exposition of the information continuum. We also describe the spiral approach of knowledge creation in terms of different modes of knowledge conversion, realizable in any of the contemporary organizations. Finally, we conclude by reiterating the various challenges of creating a communal knowledge space within the working of a learning organization.

Keywords: Learning Organization, Knowledge Architecture, Knowledge Synthesis, Knowledge Infrastructure

Introduction

At the center of organizational transformation today are the two notions of process and knowledge. The former represents not only the organization's operations characterized by clearly defined inputs, outputs and flows, but also management practices which give the organization its depth and means for handling change and turbulence. The latter is represented by a range of complexity and intellectual richness, from Plato's "justified true belief" (Nonaka & Takeuchi, 1995) to a more mundane "the capacity to act" (Sveiby, 1997). How knowledge is characterized, used, and even created within an organization is a very complicated process. Nevertheless, we believe that each member of an organization has his or her own knowledge space, which is subject to some level of description, and thus may be architected, integrated, and designed into an organization (Davenport & Prusak, 1998; Levine, 2001). As the source of wealth shifts from capital to knowledge (Drucker, 1992), it is clear that organizations that actively seek to create their own communal knowledge space from that, which exists among its members, will have a decided advantage over those who do not. One working definition of knowledge is hereby interpreted in terms of its potential for action and its ability to change context and goals – the rules of relevance and adaptation. Yet, what is the means by which a communal knowledge space may be built? And how would an organization use it for advantage? To answer these questions, the following is divided into four sections: Setting the Stage for Knowledge Synthesis; The Idea of a Learning

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Organization; Scaffolding the Knowledge Framework for Learning Organization; Recapitulating the Synthesis Challenge. The first provides the foundations on understanding the knowledge phenomenon as it is happening in many an organization today. The second serves as a digest in capturing some of the basic ideas of the learning organization. The third brings forth our conception of an actionable framework of knowledge synthesis, applicable to the Internet-based development of present-day organizations. The fourth reiterates the various challenges in doing organizational knowledge management.

Setting the Stage for Knowledge Synthesis

The last decades of the 20th century saw explosive growth in discussions about knowledge – knowledge work, knowledge management, knowledge-based organizations and the knowledge economy (Cortada & Woods, 2000). These discussions took various forms, ranging from journalistic chat, consultants' rhetoric and academic jargons, through to national policy prescriptions. In this section, we start our discussion from the relationship between the process and the value chain (Porte, 1985) within an organization. The value chain categorizes the generic value-adding activities of an organization. A value activity can be considered as a process at some level of abstraction, which serves to facilitate the alignment of an organization's business processes and change efforts. In the context of alignment, it is found that the notions of capability and competence have become increasingly important. According to (Stalk, Evans, & Shulman, 1992), a *capability* is seen as a set of strategic business processes that span the entire value chain, while a *competence* is a set of strategic knowledge areas applied to the capability at critical points along its path. The raw material for a capability or a competence is the notion of knowledge, and its devolution throughout the organization. Obviously, we must describe how and with what an organization performs its work, in terms of core capabilities (i.e., strategic processes) and core competencies (i.e., knowledge areas applied to capabilities). Here the alignment context is often expressed in terms of the dynamics of the people-process-system issue. Namely, we need to design suitable information systems to help people with knowledge to perform the processes involved to produce results of value to the organization. In fact, Zuboff (1988) has written extensively on the interaction of people and information technology (IT), and the all-important shift in management thinking from automating to informating. In practice, *automating* typically refers to the use of IT during process change to substitute the deployment of humans. Automating serves to lower uncertainty and increase management control. *Informating*, in contrast, refers to the effect IT may have on the understanding and transparency of a process. Informating makes people more productive through their use of, and process integration with IT. It serves to increase the capacity of people to understand the entire value-adding business process. Thus, informating concerns itself with the connection people have with their specific tasks as well as the whole flow of work. Certainly, the notion of knowledge cannot be neglected. While informating concerns IT and task integration, the idea of *knowledging* (Savage, 1990) refers to individual and organizational learning, and is characterized by the process of knowledge creation and the active involvement of the individual with his or her work. Knowledging includes a dynamic interaction between the known (explicit) and the vision (tacit) forms of knowledge. In fact, each context from automating to informating to knowledging, may be thought of as a stage, a progression requiring additional alignment threads and trade-off. In particular, the trade-off between individualism and community may impact the movement from informating to knowledging. Individualism drives individual knowledge and rewards, and thus encourages informating, while a community emphasizes sharing and is more closely associated with knowledging, including the interaction of computers, people, lateral relations, business processes, and organizational learning (including knowledge creation). Thereby, in order to create a communal knowledge space for the organization, each successive organizational transformation, from automating to informating to knowledging, requires higher levels of process abstraction and a broad range of process integration and alignment threads.

Classifying Knowledge Tasks and Categories

To situate our discussions about knowledge work in an organization, we first resort to the classification scheme of knowledge tasks from Charles Perrow (1970) on the basis of their analyzability (the degree to which search activity is needed to solve a problem) and variability (the number of exceptions – new or unexpected – encountered while performing a task). This results in four task subtypes: craft, routine, engineering, and non-routine. *Routine* tasks are characterized by the combination of low variability and high analyzability. Namely, few exceptions are encountered in the work process, and when an exception does occur, little search behavior is required to deal with it. *Craft* tasks are characterized by the combination of low variability and low analyzability. This means only a narrow range of exceptions being encountered but a high level of search activity is needed to find a solution to problems. *Engineering* tasks are characterized by the combination of high variability and high analyzability. Namely, the number or variety of exceptions that workers may encounter in the task is high, but finding a solution is relatively easy because well-understood standard procedures have been established to handle the exceptions. Finally, *non-routine* tasks are characterized by the combination of high variability and low analyzability. It is the most complex and least routine of the four tasks in Perrow's classification. These tasks are complex because not only is the number of unexpected situations large but search activity is high: Each new situation creates a need to expend resources to deal with it.

A key goal of management is to analyze and refine what have been craft and non-routine tasks, and thereby routinize them into routine and engineering tasks. They constantly seek to reduce the ambiguity and uncertainty by routinizing work and the business rules governing that work. Essentially, routinization requires *process explicitness*, which is applicable to such tasks with clearly defined specifications such as the administrative or operational processes. Nonetheless, organizational tasks are increasingly being craft and non-routine. Such knowledge work, by nature not clearly definable, is not easily subject to process explicitness. Routine tasks typically require low amounts of quantitative data, little or no knowledge skills, hierarchical structures, and consequently utilize unskilled people and transaction data in computer systems. As tasks become more unanalyzable (i.e., craft, non-routine), the level of ambiguity increases and requires people with relatively more experience and tacit knowledge, and a certain level of rich information. Similarly, as tasks become more variable (i.e., engineering and non-routine), the level of uncertainty increases, thereby requiring people with more training, formal education, explicit knowledge, and high quantities of information.

Meanwhile, organizational knowledge is often categorized into different knowledge areas depending on their strategic importance to the organization (contribution) and their specific stage of development (growth potential). Typically, there are four knowledge categories: (Spek & Spijkervet, 1997): promising, key, basic, and outdated. The *promising* knowledge areas are characterized by the pattern of low contribution but high growth, meaning that these areas are still in their infancy but have the potential to radically change the organization's knowledge household. The *key* knowledge areas have the pattern of high contribution and high growth. They represent the core competencies of the organization, having the greatest influence on the unique position of the organization. The *basic* knowledge areas have the pattern of high contribution but low growth. They are the essential areas for carrying out the activities of an organization, but such areas are widely available in all similar organizations. The last category is the *outdated* knowledge areas characterized by low contribution and low growth, representing knowledge, which are hardly applied any more in the organization.

Formulating Organizational Knowledge Processes

To continue our knowledge discussion in an organization context, we now turn to the idea of process formulation, the architecture-driven shaping of an organization's specific sequences of target activities. In formulating an organization's knowledge processes, our organizational context is that of knowledge

management (KM) whose mission is to prevent bottlenecks caused by an inadequate knowledge household from the perspective that knowledge is the crucial production factor. To accomplish this mission, KM entails the following activities: 1) Formulating a strategic policy for the development and application of knowledge. 2) Executing this knowledge policy with the support of all parties within the organization. And 3) improving the organization where knowledge is not optimally used or is not adapted to changing circumstances. Subsequently, we have a number of objectives set in terms of the following KM processes. First, we have to ensure an effective and efficient development of new knowledge and improvement of existing knowledge with a view to the strategy of the organization, and to individual objectives of the employees. Second, we need to ensure a specific distribution of new knowledge to other departments and to new employees through knowledge transfer or relocation of knowledge bearers. Third, we must ensure an effective securing of knowledge, which is also easily accessible to the whole organization. More, we must ensure the effective and efficient combination of the best knowledge available within an organization or network of organizations. Overall, we need a process model for implementing knowledge management. Such a model is often referred to as the KM cycle (Van der Spek & De Hoog, 1995; Spek & Spijkervet, 1997), in which KM is perceived as a cyclic process composed of four iterative activities: review, conceptualize, reflect, and act. *Review* means checking what has been achieved in the past, and what the current state of affairs is. *Conceptualize* is trying to get a view on the state of the knowledge in the organization, and analyzing the strong and weak points of the knowledge household. *Reflect* is directed toward improvements: selecting the optimal plans for correcting bottlenecks and analyzing them for risks that accompany their implementation. *Act* is the actual effectuation of the plans chosen. Obviously, the analysis, plans and actions are usually formulated in terms of the four KM processes which aim to integrate strategy formation with executive tasks so that learning about the application and development of knowledge assumes a central role within the organization.

Formulating Organizational Knowledge

To clarify the formulation of organizational knowledge, we have chosen to discuss the spiral framework for knowledge creation, attributed to Nonaka and Takeuchi (1995), whose underlying premise is that new knowledge is created as a result of the interaction of two types of knowledge (tacit and explicit) in a sequence of knowledge conversion modes. These modes are respectively the tacit-to-tacit conversion called socialization, the tacit-to-explicit conversion called externalization, the explicit-to-tacit conversion called internalization, and the explicit-to-explicit conversion called combination. The term "spiral" is used because it is believed that knowledge must not only be created, but also made manifest and crystallized into explicit knowledge, and distributed throughout the organization. The sequence of knowledge amplification – increasing knowledge crystallization and distribution among increasingly larger communities – describes a knowledge spiral among knowledge conversion modes as follows:

- *Knowledge Socialization*: tacit-to-tacit conversion. Socialization is a process of sharing experiences, usually through observation, imitation, or practice. An example is the relationship between apprentice and master. This is a well-known context where tacit knowledge is created in the head of the apprentice from existing tacit knowledge in the head of the master. The essential trigger is the facilitation of personal communication. Therefore, the organization must consciously design constructs (triggers) in which sharing experiences is possible. Such organizational constructs may include formal team structures, and office configurations (say, open space office design), which promote communication among people. Knowledge socialization often yields a set of shared skills and mental models, known collectively as sympathized knowledge.

- *Knowledge Externalization*: tacit-to-explicit conversion. Externalization is the conversion from informal to formal models of representation and specification – taking the innovative ideas of individuals and transforming them into specific concepts. This is a process of concept building that employs metaphors, analogies, and models. The essential trigger is dialogue and collective reflection, operationalized

through conversations in meetings, or other two-way, rich forms of communications. Knowledge externalization often produces conceptual knowledge.

- *Knowledge Internalization:* explicit-to-tacit conversion. This is the internalization of formalized, explicit knowledge within individuals, which leads to a broadening, extension, or reconstruction of tacit knowledge. The essential trigger is simply learning by doing. This may include simulation, role-playing, case studies, or work experience. Internalization develops operational knowledge, as explicit knowledge is absorbed into tacit knowledge.

- *Knowledge Combination:* explicit-to-explicit conversion. Combination is the formal aggregation of discrete pieces of information to create larger pieces of information; namely, combining threads of explicit knowledge to produce new threads of explicit knowledge. This is typically effected through analysis, categorization, and reconfiguration of the specific threads of knowledge. In practice, combination is the process of systematizing explicit concepts into a knowledge system. The essential trigger is the capability to network existing or newly created threads of explicit knowledge. This is typically operationalized through information technology, documentation, or meetings. Combination yields systemic knowledge, such as a new prototype, or a new component technology or method.

Recall that we describe each knowledge conversion mode in terms of its primary trigger and the resulting content that each mode yields. In practice, a trigger and the content (post-condition) can be considered as constituents of a contract specification. Each knowledge conversion mode is indeed a generic process that may be specified with something called a *knowledge contract*. And it is through knowledge contracts that organizational knowledge is created via individuals, who keep modifying their knowledge through interactions with other members. This is the process through which individuals and organizations continually refresh and update their learning – be it single-loop or double-loop learning (Argyris, 1977) – and thus share certain frameworks for knowledge creation. According to Nonaka and Takeuchi (1995), there are two dimensions related to organizational knowledge: technical and cognitive. Single-loop learning, referring to the development of the technical dimension in order to solve a specific problem, maintains an organization's activities, such as learning a new departmental procedure. On the other hand, double-loop learning, involving the cognitive dimension such as developing new mental models to replace existing one, entails a new understanding of the requirements and characteristics of a new standard procedure applicable to a department's workings. In a knowledge-creating organization, both individual and organizational learning exist, and in fact, they are intertwined, involving both the single-loop and the double-loop learning. The essence of the knowledge spiral is that all knowledge creation starts with an individual and spirals through successive conversion modes. Each successive spiral, in turn, expands its communities of interaction as a larger number of individuals, groups, and ultimately the organization become engaged with the newly created knowledge.

Embarking on the Information Continuum

To further our discussion in this section, we come to the idea of an *information continuum* attributed to Tom Davenport (1997) whose initial purpose is to help distinguish the respective business requirements for data, for information, and for knowledge, depending on the type of work being performed and the people performing the work. Typically captured in computer systems, data at one end represents easily structured states of worlds. Information, on the continuum, is "data endowed with relevance and purpose" (a quote from Peter Drucker, 1988). Information requires a unit of analysis and human intervention – "relevance and purpose" being provided by people. Knowledge, at the other end of the continuum, is information with the most value, difficult to structure or implement in computers, and usually requires some period of time for synthesis. There is also the implication that the continuum reflects a dependency: information is some form of endowed data while knowledge is a synthesis of information. This increasing richness is a function of human intervention. Actually, human involvement increases as we

move along the continuum from data to information to knowledge. Our re-interpretation of this continuum produces an updated model, which serves to contextualize information in relation to data and knowledge as items of organizational resources. In the following discussion, we attempt to characterize the information continuum in terms of specific aspects such as form, richness, context, and transformation.

- *Form.* An information continuum is characterized by its poles, which appear as the data and knowledge archetypes. There is not one intermediate point, but an infinite number of such points, representing information distinguished by some interaction of data and knowledge characteristics. At the left pole of the continuum, the data archetype represents easily defined and structured states associated with business events, while at the right pole the knowledge archetype represents pure, unoperationalized knowledge – individual tacit knowledge. Between the two poles, we have information – data endowed with relevance and purpose – defined and constrained by its process context. Relevance and purpose are determined by the application of knowledge, which may change as the context changes. While data is static, information and knowledge are dynamic, having meaning and context. In particular, information has a syntactic and semantic dimension, representing its data and knowledge characteristics, respectively.

- *Richness.* Information has varying levels of richness, which is measured by the degree of common semantic – the extent to which knowledge has been routinized. Information richness is thus a function of knowledge explicitness. Increasing routinization implies progressively less richness: individual tacit, communal tacit, explicit, routine and data structure constructs, respectively. Individual tacit knowledge is information with the most richness. It represents the knowledge archetype, and can be operationalized only through individual people, and includes their relationships and experiences. Communal tacit knowledge is information, with some richness removed – tacit knowledge shared by groups of people. This tacit knowledge is a form of knowledge that has been coalesced and functions as a collection. Explicit knowledge is generally available information, and may therefore be operationalized in computers. Routine knowledge is information with most, if not all, richness removed. Examples of routine knowledge include the rules governing create, read, update, and delete (CRUD) operations in databases, and standard operating procedures in routine tasks. Data structures are information with the least richness. They represent a specific organization of data elements.

- *Context*. Information is often turned into tacit knowledge through abstraction. Both information and tacit knowledge share a complex relationship as each elicits and feeds the other. We say that tacit knowledge establishes the context for information to reference. Tacit knowledge functions as an invariant throughout the continuum, determining relevance and purpose in real-time. Rarely does tacit knowledge become explicit knowledge without first becoming communal, which is the foundation of organizational knowledge. Tacit knowledge needs to be socialized (shared, developed and tested) and transformed into communal knowledge before it can be codified (made explicit) and leveraged by an organization. The organization's flexibility and capacity to respond to the terms of the environment can be met only through its knowledge creation and amplification. Namely, constant streams of tacit knowledge must be mobilized and crystallized into explicit knowledge threads among increasingly larger communities of people. Overall, value is created when data is captured and moved to the right on the continuum. The more knowledge is applied to data, the greater the value to the organization. Explicit knowledge is consciously constructed; routine knowledge is embedded in an organization's information systems; tacit knowledge emerges through work and experience.

- *Transformation.* Data is captured by the organization in business events, generally incarnated as routine tasks designed to gather very specific data elements. Such elements are stored in physical media such as databases or paper forms, and are made available for application processing (the application of knowledge threads) to manifest the underlying business logic. Knowledge is captured by the organiza-

tion when it acquires people through hiring, consultant engagements, or external acquisitions. Internally, knowledge may be created and codified into systems, or competencies. Indeed, when codified, knowledge may be reused if mapped into an appropriate catalog to establish topology and context – inter-related directories of business processes, data, information and knowledge. Typically, the business logic of an organization's procedural operations is executed through the data half of the information continuum – explicit and routine knowledge applied to data structures. Process tasks associated with this half are routines. The business logic of an organization's innovative activities and processes (e.g., R&D) primarily focus on the knowledge half of the continuum – explicit, communal and individual knowledge. Process tasks associated with this half of the continuum are non-routines. The business logic of an organization's core capabilities and competencies usually span the entire information continuum. The associated processes include the four types of knowledge tasks suggested by Perrow (1970): craft, routine, engineering, and non-routine.

Clarifying the Context of Organizational Knowledge

As mentioned in the Introduction of this paper, today's organizations have many knowledge spaces – one for every member of the organization. In order to develop a communal knowledge space – one that develops new forms of knowledge from that which exists among its members, we need some context for knowledge synthesis, which should help structure and facilitate knowledge implementation and interconnectivity within an organization. Experience has given us a perspective of how knowledge is characterized. For example, knowledge is open to interpretation, is constantly changing, and is synthesized over time. Besides the Nonaka and Takeuchi (1995) categorization of knowledge as *explicit* and *tacit*, Spender (1993) has provided a different characterization in terms of its social and individual dimensions. Thereby we have *scientific* knowledge and *communal* knowledge under the social category, and *conscious* and *automatic* knowledge under the individual category. In fact, each knowledge form is so much intertwined that a successful organization today will have to learn to leverage almost all of them in the development of its communal knowledge space.

- *Explicit knowledge.* This is formalized knowledge, easily expressed as principles, procedures, facts, figures, rules or formulas. As knowledge becomes more explicit, it becomes more stable, more routinized, and thus less complex in terms of its observed behavior. On the information continuum discussed previously, explicitness moves knowledge away from the knowledge pole and toward the data pole. Generally, explicit knowledge is associated with data through business processes, and they may be implemented in an organizational information system, through primitive operations such as create, read, update and delete (CRUD). However, as operations become more complex and subject to interpretation, they move away from the data pole toward the knowledge pole, and include complex processing algorithms. Such complex processes may represent the explicit knowledge component of a particular group, such as the software development team.

- *Tacit knowledge.* This is highly personal knowledge that is subjective and not easily expressible. It includes experience, ideals, emotions, intuitions, and insights. Tacit knowledge is demonstrated by the application of knowledge – the interrelationship between the content of knowledge and the associated behaviors, experiences, and feedback. Tacit knowledge has two dimensions: technical and cognitive. Technical knowledge is best described as a craft-like skill or know-how. It is highly dependent on experience. One major characteristic of technical knowledge is that the rules governing its application are usually hidden. Knowledge formation is thus dependent on observation and experience – the practice of knowledge. Cognitive knowledge is composed of schema, values and beliefs. As with the technical dimension, the cognitive dimension cannot be easily articulated, and its rules may be hidden. Cognitive mental models are constantly changing, a function of the practice of knowledge. Tacit knowledge is the foundation of innovation and creativity – all knowledge originates as tacit knowledge in the heads of

people. An idea or inspiration is tacit knowledge not yet crystallized, but defines the internal models of an individual and controls his or her perceptions and behaviors.

- *Social and Individual knowledge.* The social knowledge is shared, and may be either explicit or tacit. The most obvious kind of shared explicit knowledge is referred to as *scientific knowledge*, which is generally available. But, knowledge may be shared and tacit. This is known as *communal knowledge*; its social and tacit dimensions arise from the fact that it is taken for granted among members of an organization community. The individual knowledge is always tacit. An individual may be aware of his or her knowledge, known as *conscious knowledge*, or take it for granted, in which case it is known as *automatic knowledge*. Spender (1993) suggests that competitive advantage arise from the interaction of the four types of knowledge (scientific, communal, conscious, and automatic). An important management imperative is to transform individual tacit knowledge (conscious or automatic), which is hidden from the organization, into social tacit knowledge (communal). At the communal level, it is organizationally available, but not easily appropriated by competitors. Examples of communal knowledge include that which is associated with an organization's culture, as well as the shared tacit knowledge of a project team.

In addition to the knowledge categorization enumerated above, the development of an organization's communal knowledge space also attends to the organizational rules underlying the specific knowledge processes. These rules are typically subject to the concepts of alignment and directionality. The most important dimension of an organizational rule is its information content. As an organization's alignment context shifts from automating to informating to knowledging, these rules become less explicit, more tacit and dynamic, and dependent on real-time execution and people. On the other hand, as those rules become sufficiently routinized they may become more stable and embedded in an information pattern, which can then be captured, made explicit and transferred to an information system, thus making them available to people, who are not experts. Overall, organizational rules coexist in a complex, interactive mixture to support the development of a communal knowledge space.

The Idea of a Learning Organization

Nowadays, enterprises including educational institutes are challenged to do things faster, better and more cost-effectively in order to remain competitive in an increasingly global economy. There is a strong need to share knowledge in a way that makes it easier for individuals, teams, and enterprises to work together to effectively contribute to an organization's success. This idea of knowledge sharing has well been exemplified in the notion of a learning organization (LO) (Garvin, 1993; King, 1996; Levine, 2001; Senge, 1990). Basically, LO refers to an organization, which focuses on developing and using its information and knowledge capabilities in order to create higher-value information and knowledge, to modify behaviors to reflect new knowledge and insights, and to improve bottom-line results. Based on this characterization of LO, there are many information system (IS) instances that can be incorporated into a learning organization. The acronym "LOIS" (Learning Organization Information System) (Williamson & Lliopoulos, 2001) as applied to an organization is often used as a collective term representing the conglomeration of various information systems, each of which is a functionally defined subsystem of the enterprise LOIS. Namely, it is defined through the services it renders. For example, LOIS could support structured and unstructured dialogue and negotiation among organization's knowledge workers. They need to support reflection and creative synthesis of information and knowledge and thus integrate working and learning. They should also help document information and knowledge as it builds up, say, by electronic journals. Also, they have to make recorded information and knowledge retrievable, and individuals with information and knowledge accessible. Collectively, LOIS can be considered as a scheme to improve the organization's chances for success and survival by continuously adapting to the external environment. Consequently, we stand a better chance of increasing social participation and shared understanding within the enterprise, and thus foster better learning. Although we believe that this

positioning of LOIS represents a significant vision of a future generation of information systems, there are serious questions to be addressed in connection with knowledge capture and transformation, as well as knowledge asset management within the enterprise. These have consequences for enterprise transformation in such areas as strategies, structures, processes, systems and people. The philosophy underlying the LOIS design should recognize that our knowledge is the amassed thought and experience of innumerable minds and LOIS helps capture and reuse those experiences and insights in the enterprise. The notion that emerges resembles strongly the classical history paradigm of learning from past events, necessitating the collection of data and repeated re-interpretation of its meaning, significance and impact for next generations. That is also the idea of organizational learning (Kim, 1995), supported by an organizational memory (Conklin, 1996). Organizational memory is considered as the means by which knowledge from the past is continuously brought to bear on present activities. It should possibly result in higher or lower levels of organizational effectiveness (Stein, 1992) in terms of the decision-making, organizing, leading, designing, controlling, communicating, planning and motivating functions of the management process. The cultivation of an electronic version of organizational memory is fundamental to enterprises that intend to establish, grow and nurture a digital learning organization (Hackbarth & Groven, 1999), where individuals grow intellectually and expand their knowledge by unlearning inaccurate information and relearning new information. Oftentimes, there is the essential difference between doing it the way we always did it (single-loop learning) and arriving at an innovative solution that establishes new patterns and relationships (double-loop learning) (Argyris, 1992; Kim, 1995).

Scaffolding the Knowledge Framework for Learning Organization

In order to create value through knowledge-synthesis activities, an organization needs a vision that orients the entire organization to the kind of knowledge it must acquire, and wins spontaneous commitment by the individuals and groups involved in knowledge creation (Dierkes, Marz, & Teele, 2001; Stopford, 2001). It is top management's role to articulate this knowledge vision and communicate it throughout and beyond the organization. A knowledge vision should define what kind of knowledge the organization should create in what domains. It helps determines how an organization and its knowledge base will evolve in the long run. Because knowledge is without boundaries, any form of new knowledge can be created regardless of the organization's business structure. The knowledge vision should also define the value system according to which we evaluate, justify, and determine the quality of knowledge created. In practice, together with organizational norms, routines, and skills, the value system determines what kinds of knowledge are needed, created, and retained (Leonard-Barton, 1995; Nonaka & Takeuchi, 1995). On the other hand, the central requirement for organizational knowledge synthesis is to provide the organization with a strategic ability to acquire, create, exploit, and accumulate new knowledge continuously and repeatedly in a circular process. To meet this requirement, we need an actionable framework for knowledge synthesis, which could facilitate the installation of this strategic ability.

Knowledge Framework for Learning Organization

It is believed that there are at least three major elements constituting the knowledge framework of a learning organization, including the knowledge architecture, the knowledge synthesis process, and the technical knowledge infrastructure. The knowledge architecture, being a component of the overall organizational architecture, is responsible for generating an ever- growing body of organizational knowledge. The knowledge synthesis process provides the formal methodology for collecting, integrating, and disseminating knowledge. The technical knowledge infrastructure, increasingly being virtualized over the Internet in every organization, should allow every individual to gain access to knowledge wherever and whenever it is needed.

The Knowledge Architecture

With the idea of a learning organization, we suggest the creation of a number of architectural components in the knowledge architecture (Vat, 2001, 2003), which are intended to facilitate learning, and the creation, acquisition, plus distribution of knowledge, among organizational members.

- *The IS-component*. This component operates on the information system (IS) paradigm (King, 1996; King, 1999) of identifying relevant data, acquiring it, and incorporating it into storage devices that are designated to make it readily available to users in the form of explicit knowledge such as routine reports and responses to inquiries. Principally, IS directly relates to managing data and information rather than knowledge and learning. But, the IS infrastructure, including the application programs which transform data into more valuable information relating to particular decisions, functions or activities in the organization, is of fundamental importance to implementing any of the other architectural components for knowledge synthesis.

- *The IL-component.* The individual learning (IL) (Kim, 1993) component serves to provide training and education for individuals through the institution of workshops, apprenticeship programs and the establishment of informal mentoring programs. Typically, an IL component provides free use of the IS infrastructure to access unstructured material in order to pursue an explicit educational path, and to access structured learning material purposely designed for online self-learning. The organization that adopts the IL component in pursuit of a learning organization is betting on its people; namely, enhanced individual learning will translate into improved organizational behaviors and performance.

- *The OL-component.* The organizational learning (OL) (Grant, 1996; Probst & Buchel, 1997) component focuses on the use of communities of practice approach, leading to the formation of collaborative groups composed of professionals who share experience, knowledge and best practices for the purposes of collective growth. The conceptual basis is that group-based organizational competencies and capacities, can be developed, refined and enhanced to enable the organization to adapt to changing circumstances and demands, through such ideas as teamwork, empowerment, case management or development-centered career paths.

- *The IPM-component.* This component deals with the issue of intellectual property management (IPM) (Stewart, 1997; Sveiby, 1997; Wiig, 1997) underlying the activities that are involved in leveraging existing codified knowledge assets in the form of patents, brands, copyrights, research reports, and other explicit intellectual properties of the organization. The organization that pursues the IPM component in support of a learning organization may devise a financial incentive that allows individuals and groups to be rewarded for the creation and leveraging of intellectual properties.

- *The KM-component.* The knowledge management (KM) (O'Leary, 1998) component focuses on the acquisition, explication, and communication of mission-specific professional expertise that is largely tacit in nature to organizational participants in a manner that is focused, relevant and timely (Grant, 1996; King 1999; van der Spek & De Hoog, 1995; Wiig, 1993). The conceptual basis is that an organization's tacit knowledge can, in part, be made explicit, and leveraged through the operation of KM-related processes and systems developed for knowledge sharing.

The Knowledge Synthesis Process

Knowledge synthesis is a social as well as an individual process. Sharing tacit knowledge requires individuals to share their personal beliefs about a situation with others. At that point of sharing, justification becomes public. Each individual is faced with the tremendous challenge of justifying his or her beliefs in front of others – and it is this need for justification, explanation, persuasion and human connection that makes knowledge synthesis a highly fragile process. To bring personal knowledge into a social context, within which it can be amplified or further synthesized, it is necessary to have a field that pro-

vides a place in which individual perspectives are articulated, and conflicts are resolved in the formation of higher-level concepts. In a typical organization, the field for interaction is often provided in the form of an autonomous, self-directed work team, made of members from different functional units. It is a critical matter for an organization to decide when and how to establish such a team of interaction in which individuals can meet and interact. This team triggers organization knowledge synthesis mainly through several steps. First, it facilitates the building of mutual trust among members, and accelerates creation of an implicit perspective shared by members as tacit knowledge. The key factor for this step is sharing experience among members. Second, the shared implicit perspective is conceptualized through continuous dialogue among members. The dominant mode of knowledge conversion here is externalization. Tacit field-specific perspectives are converted into explicit concepts that can be shared beyond the boundary of the team. Dialogue directly facilitates this process by activating externalization at the individual levels. It is a process in which one builds concepts in cooperation with others. It provides the opportunity for one's hypothesis or assumption to be tested. As Markova and Foppa (1990) argue, social intercourse is one of the most powerful media for verifying one's own ideas. As such, participants in the dialogue can engage in the mutual co-development of ideas. Next comes the step of justification, which is the process of convergence and screening, which determines the extent to which the knowledge created within the team is truly worthwhile for the organization. Typically, an individual justifies the truthfulness of his or her beliefs based on observations of the situation; these observations, in turn, depend on a unique viewpoint, personal sensibility, and individual experience. When someone creates knowledge, he or she makes sense out of a new situation by holding justified beliefs and committing to them. Under this definition, knowledge is a construction of reality rather than something that is true in any abstract or universal way. The creation of knowledge is not simply a compilation of facts but a uniquely human process that cannot be reduced or easily replicated. It can involve feelings and belief systems of which we may not even be conscious. Nevertheless, justification must involve the evaluation standards for judging truthfulness. There might also be value premises that transcend factual or pragmatic considerations. The inducements to initiate a convergence of knowledge may be multiple and qualitative rather than simple and quantitative standards. Finally, we arrive at the stage of cross-leveling knowledge. During this stage, the concept that has been created and justified is integrated into the knowledge base of the organization, which comprises a whole network of organizational knowledge.

The Kowledge Infrastructure

The knowledge infrastructure supporting the idea of learning organization could include a three-tiered Web-enabled configuration, including the front-end KM services (KMS), the middle-layer KM architecture (KMA), and the back-end organizational memory (OM) (Vat, 2000, 2002) Typically, various KM services, incrementally designed for the specific learning organization, could be made available to its users in the form of different distributed Web-based applications, each being interpreted as the iterative means to realize the specific KM processes for organizational knowledge transfer. The specific KM services constituting the individual LOIS sub-systems are made possible through packing the designated intranet-based or extranet-based services into a suitable Web information system. It is believed that a well-devised LOIS with user-friendly KMS's enhances the probability of seamless, flexible knowledge acquisition, sharing, and integration among knowledge workers throughout the organization. The challenge is how to design KMS's to enable spontaneous knowledge transfer so as to turn the scattered, diverse knowledge of our knowledge workers into well-structured knowledge assets ready for deposit and reuse in the OM (De Hoog, et al., 1994, 1996).

- ***The knowledge management services (KMS)***. The design of front-end KM services is an attempt to recognize the human assets within the minds of individuals and to leverage them as organizational assets that can be accessed and used by a broader set of individuals on whose decisions the organization depends. As mentioned previously, organizational knowledge can be created through the interactions

between tacit knowledge and explicit knowledge (Nonaka & Takeuchi, 1995) according to the socialization-externalization-combination-internalization process. Consequently, our KM services can be devised based on these four modes of interactions. The 'Knowledge Socialization' process usually occurs in the form of informal communication when someone raises a question for discussion or an issue to be responded. It should receive direct ICT (information and communications technology) support that makes users communicate without imposing any particular structure on their interaction. The suitable KMS could include discussion forum, or some brainstorming applications. The 'Knowledge Internalization' process occurs when we are actively searching for methods or lessons learned to solve problems at hand. We do knowledge interpretation from other colleagues' previous work, and we internalize knowledge by doing, and also by observing what other people have done in a similar context and by example. The suitable ICT elements should focus on recording explicit knowledge making it available to potential users and enabling them to re-experience what other have done in similar situations. The corresponding KMS could include lessons-learned databases, and process history tracking applications. The 'Knowledge Externalization' process, aimed to structuring knowledge and making it available to other users, involves concept mapping, tacit knowledge categorization and representation. The suitable ICT elements could include semantic networks and knowledge ontologies. The KMS should focus on creating an OM to support knowledge preservation and creation. The 'Knowledge Combination' process involves various knowledge sharing and decision coordination. The ICT elements should focus on combining pre-existing explicit knowledge to produce new insights. The KMS could appear in the form of document management system, group support system, and the workflow system.

- ***The knowledge management architecture (KMA)***. The KMA acts as the middle layer in support of the front-end KMS through the back-end OM. Its logical requirements are to satisfy the KM concerns to create, retain, share, and leverage knowledge from the personal level to the team level, the organizational level, and even the inter-organizational level. Its development is conceived from two architectural perspectives: the business architecture, and the technology architecture. The former involves the development of management solutions that are related to modeling the business functionality of the organization; namely, business strategies, processes and structures that enhance and facilitate organization-wide knowledge leveraging. The latter involves the development of ICT components within an intranet-based knowledge medium to translate the organization's business vision into effective electronic applications that support the intra- and inter-organizational KM services.

The KMA's Business Architecture. This business architecture could be designed to comprise a number of distinct KM-related components: e-Business models, e-Process models, and e-Application models, where 'e' denotes electronic. The e-Business model is aimed to provide a high-level perspective of the business initiative. The e-Process model is aimed to describe the internal and external processes representing the organization's daily behavior. The e-Application model is aimed to represent the electronic applications to be developed to streamline business processes from the end-user perspective. An example might be to support such aspects of a learning organization as knowledge diagnosis, and knowledge transformation. Knowledge diagnosis helps determine the most critical areas of knowledge capture and creation within the organization. Knowledge transformation involves such issues as the mapping of knowledge to empower personnel to quickly and accurately locate sources of knowledge applicable to specific business problems; and creation of reward systems that facilitate openness, improvisation, integrity, creativity, team-spirit, trust and ability to change.

The KMA's Technology Architecture. This technology architecture could be composed of distinct stages of development such as e-Application rules, e-Application resources, and e-Application distribution, where 'e' denotes electronic. The e-Application rules are the technical mechanisms, which enforce business rules that are peculiar to every business process to govern its operations. Typical components of e-Application rules include business objects and application frameworks to implement the business requirements. The e-Application resources comprise items of resources (data, information, knowledge)

stored and manipulated by the electronic applications (KM services). The heart of the e-Application distribution is a distributed architecture, which allows application resources to be located on individual application servers. These servers are typically connected by a network infrastructure, which provides a backbone of communication among the multiple distributed platforms of the organization, and which communicates using standard such as CORBA and J2EE.

- ***The organizational memory (OM).*** The KM processes involved in organizational learning, often require iterations of references and modification of the components developed in the business and the technology architectures of the KMA. This requirement implies the importance of a reusable asset repository for storing various business-specific and technology-related components in the form of tacit and explicit knowledge items. Our OM could be designed to fulfill this specific requirement. Particularly, the OM could be configured differently for various purposes. For example, it could be structured into the business repository and the technology repository. Typically the business repository stores knowledge items we can use to standardize definitions of business and process models. And we can archive existing process components, which can then be recalled later by coworkers in other departments to be reused or modified for new process models. Similarly, the technology repository stores technology resources such as 'business objects', pre-built and purchased components, developer documentation, and numerous other technology standards.

Conclusion: Recapitulating the Synthesis Challenge

Organizations play a critical role in mobilizing tacit knowledge held by individuals and provide the forum for a spiral of knowledge creation through socialization, combination, externalization, and internalization. All of these conversion modes interact in a dynamic and continuous entanglement to drive the knowledge synthesis process. These modes operate in the context of an organization and, while acknowledging the role of individuals as essential actors in synthesizing knowledge, the central consideration is to address the processes involved at an organizational level. Namely, it is important to develop organizationally the ability to switch between various contexts of knowledge synthesis (acquisition, generation, exploitation, and accumulation) to accommodate changing requirements from situations both inside and outside the organization. This requirement is a direct challenge to the classic model of viewing an organization as a bureaucratic information-processing machine. This traditional model is based on an implicit assumption that information and knowledge are processed most efficiently through a tree structure. The division of labor within this kind of bureaucratic organization is associated with a hierarchical pattern of information processing. Simple and select information is passed up the pyramid to top management, who then uses it to create plans and orders, which are passed back down the hierarchy. In this model, information created by the top management exists for the sole purpose of implementation. Thus, information serves as a tool rather than a product. As pointed out in the previous discussion, intense interactions among organizational members are a key to organizational knowledge synthesis. However, such interactions hardly take place in the hierarchy of the top-down organizational model where more often than not, knowledge management has been myopically interpreted as simply information management. Typically, knowledge management efforts involves breaking information into smaller chunks that can be detected throughout the organization, stored for later use, manipulated by being combined with other chunks, and transferred where they are needed. Information under this rubric covers a range of items: documents, policies, databases, and procedures. The ultimate goal of knowledge management is to get the right information to the right people at the right place – and it depends on information technology. This is not a new approach, nor is it trivial. Information management is certainly needed in all organizations, and careful handling and storage of information can result in tremendously positive outcomes for the organization. Yet, the issue here is not one of relevance but of categorization. In many knowledge management approaches, information and knowledge are equated. But, these approaches fail to make the fundamental distinction between information and knowledge or to account for

the different management styles and activities required. As discussed earlier, information is data put in context; it is related to other pieces of data. Information is also about meaning, and it forms the basis for knowledge. Yet, knowledge goes one step farther: It encompasses the beliefs of groups or individuals, and it is intimately tied to action. In an organization, members hold both tacit and explicit knowledge, which allows for competent collective action. They might share explicit social knowledge embedded and routinized, sometimes formalized in organizational procedures for solving a task. Yet even explicit social knowledge cannot all be captured in writing or turned into routines; some might be shared orally or by example, such as when to use the procedure, and the possible limits and exceptions to it. More, much of social knowledge is also tacit. It involves shared beliefs about a situation that are justified but not explicit. Such tacit knowledge can be task-specific, but more general issues such as how to relate in a group, deal with a stressful situation, or handle leadership are also part of a community's social tacit knowledge. What this means is that knowledge is not simply information, especially when it is tacit and shared with other community members. Beliefs, commitments, and actions cannot be captured and represented in the same manner as information. Nor is knowledge always detectable; it is created spontaneously, often unpredictably. Therefore, when organizations put information and knowledge into the same category, they are prone to neglect the very particular nature of knowledge and its creation. To be sure, information technology is helpful, perhaps indispensable, in the modern organization. But, information systems design meets a great challenge in facilitating a group's commitment to a concept, sharing emotions tied to tacit experience, or embodying the knowledge related to a certain task. The human skills that drive knowledge creation have much more to do with relationships and community building than databases. Investments in information technology alone cannot induce a knowledge-creating learning organization.

References

Argyris, C. (1977). Double loop learning in organizations. *Harvard Business Review*, Vol. 55, No. 5, pp. 115-125.

Argyris, C. (1992). *On organizational learning.* Cambridge, MA: Blackwell Business.

Conklin, E.J. (1996). Designing organizational memory: Preserving intellectual assets in a knowledge economy. White paper in *Group Decision Support Systems,* Washington, D.C.; http://www.gdss.com/DOM.htm

Cortada, J.W. & Woods, J.A. (2000). *The knowledge management yearbook 2000-2001*. (Eds.), Butterworth-Heinemann.

Davenport, T.H. (1997). *Information ecology: Mastering the information and knowledge environment.* Oxford University Press.

Davenport, T.H., and Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Boston, Mass. Harvard Business School Press.

De Hoog, R., et al. (1994). Organization model: Model definition document. Technical Report. *Univ. Amsterdam and Cap Programmator.* Deliverable DM6.2c of ESPRIT Project P5248 (KADS-II).

De Hoog, R., et al. (1996). The CommonKADS organization model: Content, usage, and computer support. *Expert Systems with Applications, Vol. 11*, No. 1, July, pp. 247-260.

Dierkes, M., Marz, L. & Teele, C. (2001). Technological visions, technological development, and organizational learning. in M. Dierkes, A.B. Antal, et al. (eds.), *Handbook of Organizational Learning and Knowledge.* Oxford University Press, pp. 282-304.

Drucker, P.F. (1988) The coming of the new organization. *Harvard Business Review*, January-February.

Drucker, P.F. (1992). The new society of organizations. *Harvard Business Review*, September-October.

Garvin, D.A. (1993). Building a learning organization, *Harvard Business Review*, Vol.71, No. 4, pp. 78-91.

Grant, R.M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17 (Winter Special Issue), pp. 109-122.

Hackbarth, G., and V. Grover (1999). The knowledge repository: Organization memory information systems. *Information Systems Management,* Vol. 16, No. 3, pp. 21-30.

Kim, D. (1993). The link between individual and organizational learning. *Sloan Management Review*, (Fall), pp. 37-50.

Kim, D. (1995). *Managerial practice fields: Infrastructure of a learning organization.* Productivity Press.

King, W.R. (1996). IS and the learning organization. *Information Systems Management, 13* (3), Fall 1996, pp. 78-80.

King, W.R. (1999). Integrating knowledge management into IS strategy. *Information Systems Management, 16* (4), Fall 1999, pp. 70-72.

Leonard-Barton, D. (1995). *Wellsprings of knowledge: Building and sustaining the sources of innovation.* Boston: Harvard Business School Press.

Levine, L. (2001). Integrating knowledge and processes in a learning organization. *Information Systems Management*, Winter, pp. 21-32.

Markova, I. & Foppa, K. (Eds.). (1990). *The dynamic of dialogue*, New York: Harvester Wheatsheaf.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge creating company: How Japanese companies create the dynamics of innovation*. Oxford University Press.

O'Leary, D.E. (1998). Enterprise knowledge management. *IEEE Computer, Vol. 31*, No. 3, Mar. 1998, pp. 54-61.

Perrow, C. (1970). *Organizational analysis: A sociological view*. Belmont, CA, USA: Wadsworth.

Porter, M.E. (1985). *Competitive advantage: Creating and sustaining superior performance.* New York, NY The Free press, A Division of Macmillan, Inc.

Probst, G. & B. Buchel (1997). *Organizational learning: The competitive advantage of the future*. Herdsfordshire, UK: Prentice-Hall (Europe).

Savage, C.M. (1990). *Fifth generation management: Integrating enterprises through human networking.* Digital Press.

Senge, P. (1990). *The fifth discipline: The art and practice of the learning organization*. London: Currency Doubleday.

Spek, R. van der, & Spijkervet, A. (1997). Knowledge management: Dealing intelligently with knowledge. In: J. Liebowitz and L.C. Wilcox (eds.), *Knowledge Management and Its Integrative Elements*. New York, USA: CRC Press, pp.31-59.

Spender, J.C. (1993), Competitive advantage from tacit knowledge? Unpacking the concept and its strategic implications. *Academy of Management Best Papers Proceedings 1993*, pp. 37-41.

Stalk, Jr., G., Evans, E. & Shulman, L.E. (1992), Competing on capabilities: The new rules of corporate strategy. *Harvard Business Review,* March-April.

Stein, Eric W. (1992). A method to identify candidates for knowledge acquisition. *Journal of Information Systems,* Vol. 9, No. 2, pp. 161-178.

Stewart, T.A. (1997). *Intellectual capital: The new wealth of organizations.* New York: Doubleday.

Stopford, John, M. (2001). Organizational learning as guided responses to market signals. in M. Dierkes, A.B. Antal, et al. (eds.), *Handbook of Organizational Learning and Knowledge.* Oxford University Press, pp. 264-281.

Sveiby, K.E (1997). *The new organizational wealth*. Berrett-Koehler Publishers.

Van der Spek, R., & De Hoog, R. (1995). A framework for a knowledge management methodology. In: Wiig, K.M. (ed.), *Knowledge Management Methods.* Arlington, TX, USA: Schema Press, pp. 379-393.

Vat, K.H. (2000). Designing knowledge infrastructure for virtual enterprises in organizational learning. in *Proceedings of the Tenth Annual Business Information Technology Conference* (BIT2000), Nov. 1-2, Manchester, England, (CD-ROM Paper No. 45).

Vat, K.H. (2001), Towards a learning organizational model for knowledge synthesis: An IS perspective. in CD-*Proceedings of the 2001 Information Systems Education Conference* (ISECON2001), in Cincinnati, Ohio, USA, on Nov. 1-4.

Vat, K.H. (2002). Designing organizational memory for knowledge management support in collaborative learning. in: *D. White (Ed.), Knowledge Mapping and Management (ISBN 1-931777-17-9)*, IRM Press (Idea Group Inc.): Hershey, USA, pp. 233-243.

Vat, K.H. (2003). An IS-based architectural modeling for learning organization: A conceptual walkthrough. in the *Proceedings of the Sixth Annual Conference of the Southern Association for Information Systems* (SAIS2003), Mar. 1-2, Savannah, Georgia, USA, pp. 55-62.

Wiig, Karl, M. (1997). Integrating intellectual capital and knowledge management. *Long Range Planning, 30* (3), June 1997, pp. 399-405.

Wiig, K.M. (1993). *Knowledge management: The central management focus for intelligent-acting organizations.* Arlington, TX, USA: Schema Press.

Williamson, A. and Lliopoulos, C. (2001). The learning organization information system (LOIS): Looking for the next generation. *Information Systems Journal, Vol. 11*, No. 1, Jan., pp. 23-41.

Zuboff, S. (1988). *In the age of the smart machine: The future of work and power*. New York. Basic Books.

Biography

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