Chapter 1.27
Knowledge Synthesis Framework

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INTRODUCTION

The last decade 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). At the center of such discussions 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, this article is divided into five sections: The Background of Knowledge Synthesis; Pursuing the Ideal of a Learning Organization; Scaffolding the Knowledge Framework; Future Trends of IS Design for Knowledge Sharing; and Conclusion.

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 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 discusses some of the challenges in information systems (IS) design for knowledge work. The fifth concludes the article by reiterating the challenges in doing organizational knowledge synthesis.

The theme of this article is to investigate strategies to enhance knowledge sharing through the idea of a learning organization. Its aim is to conceive appropriate design of IS support so as to expand an organization's capacity to adapt to future challenges.

THE BACKGROUND OF KNOWLEDGE SYNTHESIS

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). There are 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 handle 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 should 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 transform 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. Nonetheless, organizational tasks are increasingly being craft and non-routine. Such knowledge work is not easily subject to process explicitness (clearly defined specifications). 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. Obviously, such is the backdrop behind which many an enterprise today has been developing their contexts for organizational knowledge synthesis.

In order to develop a communal knowledge space—one that develops new forms of knowledge from that which exists among its members—we must describe how and with what an organization performs its work, say, in terms of its core capabilities (i.e., strategic processes) and core competencies (i.e., knowledge areas applied to capabilities) (Stalk, Evans, & Shulman, 1992). Oftentimes the alignment context is 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 writ-

ten 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 must be incorporated. While informating concerns IT and task integration, the idea of knowledging (Savage, 1996) 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.

PURSUING THE IDEAL 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; Vat, 2001). Basically, a learning organization could be considered as an organization that 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 possible IS instances that could be incorporated into a learning organization. The acronym "LOIS" (Learning Organization Information System) (Vat, 2003; 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, being a functionally defined subsystem of the enterprise LOIS, is distinguished through the services it renders. For example, if a LOIS could support structured and unstructured dialogue and negotiation among the organizational members, then the LOIS subsystems might 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. Or, they have to make recorded information and knowledge retrievable, and individuals with information and knowledge accessible. Collectively, a 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 intellectual asset management within the enterprise. All these have consequences for organization transformation in such areas as strategies, structures, processes, systems, and people. More importantly, the philosophy underlying the LOIS design should recognize that our knowledge is the amassed thought and experience of innumerable minds, and the LOIS helps capture and reuse those experiences and insights in the enterprise. The notion that emerges strongly resembles 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 (Senge et al., 1994), supported by an organizational memory (Conklin, 1996)—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 a communal knowledge space based on the 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; Senge et al., 1994).

SCAFFOLDING THE KNOWLEDGE FRAMEWORK

In order to create the communal knowledge space for the entire organization, 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 the organization. A knowledge vision should define what kind of knowledge the organization should create in what domains. It helps determine how an organization and its knowledge base will evolve in the long run (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, which could facilitate the installation of this strategic ability. 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 first, being a component of the overall organizational architecture, is responsible for generating an ever-growing body of organizational knowledge. The second provides the formal methodology for collecting, integrating, and disseminating knowledge. The third, 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

Following 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 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 organization's 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 a 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 provides 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 up 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 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. Second, the shared implicit perspective is conceptualized through continuous dialogue among members. Tacit field-specific perspectives are converted into explicit concepts that can be shared beyond the boundary of the team. 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.

Next comes the step of justification, 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. Accordingly, when someone creates knowledge, he or she makes sense out of a new situation by holding justified beliefs and committing to them. Indeed, 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. Finally, we arrive at the stage of cross-leveling knowledge (Nonaka, Toyama, & Konno, 2002). 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 Knowledge Infrastructure

The knowledge infrastructure supporting the idea of a learning organization is based on a simple philosophy; namely, various knowledge services, in support of a specific LOIS context (say, the creation of a communal knowledge space), must be interpreted as the essential means to realize the particular synthesis processes for organizational knowledge transfer. And such services could be made available to their users in the form of different distributed Web-based applications, which are each designed and tested incrementally and iteratively according to the purposeful activities of the organizational scenarios. The challenge is how to design the infrastructure to enable spontaneous knowledge capture and transfer so as to turn the scattered, diverse knowledge of individual knowledge workers into well-structured knowledge assets ready for reuse in the organization (De Hoog, Benus, Vogler, & Metselaar, 1996). Accordingly, adoption of a three-tiered configuration—composed of respectively the front-end KM services (KMS), the middle-layer KM architecture (KMA), and the back-end organizational memory (OM)—is suggested (Vat, 2000, 2002).

- The knowledge management services (KMSs): 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. According to Nonaka and Takeuchi (1995), organizational knowledge can be created through the interactions between tacit and explicit knowledge based

on the SECI (socialization, externalization, combination, and 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 that requires a response. The 'knowledge internalization' process occurs when we are actively searching for methods or lessons learned to solve problems at hand. We internalize knowledge by doing, and also by observing what other people have done in a similar context and by example. The 'knowledge externalization' process is aimed at structuring knowledge and making it available to other users. It involves concept mapping, tacit knowledge categorization, and representation. The 'knowledge combination' process involves various knowledge sharing and decision coordination.

- The knowledge management architecture (KMA): The KMA acts as the middle layer supporting 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 information and communications technology (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 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. The OM could be designed to fulfill this specific requirement. 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 organizational 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.

FUTURE TRENDS OF IS DESIGN FOR KNOWLEDGE SHARING

According to Checkland and Holwell (1995), the main role of an information system is that of a support function. The IS function is to support people taking purposeful action by indicating that the purposeful action can itself be expressed via some activity models, which are called the "human activity systems" (HAS) models from the perspective of soft systems methodology—SSM

(Checkland & Scholes, 1990). The job of providing IS support can then be thought about as entailing a pair of systems, one a system which is served (the people taking the action), and the other a system which does the serving. Thereby, whenever a system serves or supports another, it is a very basic principle of SSM (Checkland, 1983) that the necessary features of the serving system can be worked out only on the basis of a prior account of the system served. This is because the nature of the system served—the way it is thought about—will dictate what counts as service, and hence what functions the system which provides that service must contain (Checkland, 1981, p. 237). Thus, an IS strategy concerning support to an organization, such as a LOIS, can be coherently designed and set up only on the basis of a clear concept of the knowledge sharing context. This is true not only for the IS strategy of the learning organization as a whole, but also for the thinking concerning each detailed system created within that strategy. Consequently, the process of IS development needs to start not with attention quickly focused on data and technology, but with a focus on the actions served by the intended organizational system. Once the actions to be supported have been determined and described (using various HAS-based activity models), we can proceed to decide what kind of support should be provided, say: automating action which is currently being carried out by people; or informating people (providing information support to people) (Zuboff, 1988); or knowledging teams of people (facilitating their social and mental exchange) (Savage, 1996) as they carry out their tasks. In each case, we need to determine what will help people take the desired action, and what will help to monitor the action and make adjustments if desired outcomes are not emerging. Often the monitoring and control needs to be thought about carefully in terms of some declared measures of performance, which should derive from how the purposeful activity is conceptualized. The key point is that in order to create the necessary IS support that serves the intended organizational scenario, it is first necessary to conceptualize the organizational system that is to be served, since this order of thinking should inform what relevant services would indeed be needed in the IS support.

CONCLUSION

This article describes an initiative to develop an actionable framework for knowledge synthesis, paying particular attention to the design issues in support of participatory knowledge construction, in the context of organization transformation in today's prevailing knowledge economy. Our discussion intends to clarify the ideal of a learning organization (LO) 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. In particular, we have elaborated the design issues of the LOIS support that help structure and facilitate knowledge interconnectivity, in terms of a three-tiered technical knowledge infrastructure comprising the front-end knowledge management services, the mid-layer of knowledge management architecture, and the back-end organizational memory. To realize the LOIS support, it is also necessary to examine the underlying processes in which, in a specific organizational context, a particular group of people can conceptualize their world and hence the purposeful action they wish to undertake. We need to understand why, among these people, certain data are selected and treated as relevant items in order to get the best possible definitions of accepted purposes and the intentional action that follows from pursuing them. The examination of meanings and purposes, in support of designing the necessary IS functions, should be broadly based, and its richness will be greater the larger the number of people who take part in it. Nevertheless, the examination should try to home in on the question: If we want to

pursue this purpose, which seems meaningful to us, what would we have to do and how could we do it? Remembering the many possible relationships that have to be managed, we have to acknowledge the rarity of complete consensus among different people. What are sought are often the accommodations, which enable some meaningful work to be sustained in undertaking actions relevant to plausible purposes. This consequently provides the basis for ascertaining the organization's communal knowledge space: namely, what IS support is truly needed by those undertaking their actions, and how modern IT can help to provide that support.

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