

**Information Technology and Organizational Learning:  
A Review and Assessment of Research**

Daniel Robey

Marie-Claude Boudreau

Gregory M. Rose

Department of Computer Information Systems

Georgia State University

November 1999

Forthcoming: *Accounting, Management and Information Technologies*

The authors appreciate the comments of Timo Käkölä and Kalle Lyytinen on previous drafts.

# **Information Technology and Organizational Learning:**

## **A Review and Assessment of Research**

### **Abstract**

This paper reviews and assesses the emerging research literature on information technology and organizational learning. After discussing issues of meaning and measurement, we identify and assess two main streams of research: studies that apply organizational learning concepts to the process of implementing and using information technology in organizations; and studies concerned with the design of information technology applications to support organizational learning. From the former stream of research, we conclude that experience plays an important, yet indeterminate role in implementation success; learning is accomplished through both formal training and participation in practice; organizational knowledge barriers may be overcome by learning from other organizations; and that learning new technologies is a dynamic process characterized by relatively narrow windows of opportunity. From the latter stream, we conclude that conceptual designs for organizational memory information systems are a valuable contribution to artifact development; learning is enhanced through systems that support communication and discourse; and that information technologies have the potential to both enable and disable organizational learning. Currently, these two streams flow independently of each other, despite their close conceptual and practical links. We advise that future research on information technology and organizational learning proceeds in a more integrated fashion, recognizes the situated nature of organizational learning, focuses on distributed organizational memory, demonstrates the effectiveness of artifacts in practice, and looks for relevant research findings in related fields.

## Introduction

The turn of a century conveniently punctuates history, marking the end of a prior era and provoking new visions of the future. For organizational scientists, the end of the twentieth century has witnessed an unprecedented obsession with organizational transformation and improvement. Traditional bureaucratic forms have been declared a competitive liability, and proposals for radical new forms have appeared with striking regularity. Many theoretical arguments underlie current proposals for organizational reform: economists assert the supremacy of markets over hierarchies; technologists advocate process-centered, virtual organizations enabled by information technologies; and behaviorists promote renewal through organizational learning and knowledge management. Although the popularity of alternative approaches shifts rapidly, parallel interests in *information technology* and *organizational learning* have been sustained for the last quarter century. Only recently, however, has research begun to address information technology and organizational learning together.

It is easy to account for the current popularity of organizational learning. For many, organizational learning offers an optimistic and humanistic antidote to the problems plaguing organizations as they struggle with the transition from an industrial age to an information age. The images of an organization learning new behaviors and mindfully managing its knowledge resources certainly offer more palatable metaphors for organizational transition than the radical surgery of process reengineering or the hollow created by outsourcing and downsizing. Organizational learning emphasizes managerial vision, leadership, communication, and teamwork within human systems (Senge, 1990). By contrast, Hammer's (1990) original salvo in the reengineering movement called for the obliteration of existing work processes and the creation of radically different processes enabled by new information technologies. Subsequently,

Hammer (1996) revised his arguments to include a substantial role for learning in the process of organizational change. Thus, organizational learning's persuasive appeal touched even the 1990s' most outspoken organizational engineer.

Although the link between information technology and organizational learning has only begun to be explored, two related streams of research can be identified. The first adopts organizational learning as a means for explaining and resolving the problems of implementing and using new information technologies in organizations. This stream originated in Argyris' (1977) claim that organizational learning would be instrumental in overcoming implementation problems. Despite this early and authoritative appeal, organizations continue to struggle frequently in their efforts to use new technologies effectively. Research examining the ways in which organizations learn to use information technology effectively can potentially contribute to resolving such problems. The second stream of research develops applications of information technology to support the processes of organizational learning and knowledge management. For example, technologies such as data warehousing, expert systems, best-practice databases, and intranet/internet systems potentially comprise valuable components of organizational memory (Stein and Zwass, 1995), whereas groupware and wide-band communication networks may facilitate access to and usage of memory. Information technology can thus be an important ingredient in the design of "learning organizations" by providing an infrastructure for storing, accessing, and revising some of the elements of organizational memory.

Figure 1 provides a classification diagram covering the empirical literature that is reviewed in this paper. The two streams of research mentioned above are the primary basis of classification, with other tributaries to each stream also identified.

---Insert Figure 1 about here---

Although typically pursued independently, the two research streams are closely linked conceptually. Before an organization can leverage information technology to enable organizational learning, the appropriate technologies must be implemented and used. Ironically, however, the successful implementation of the technologies that enable organizational learning depends on an organization's present capacity to learn. Thus, organizations that already exhibit learning capabilities should find it easier to increase their capacity to learn because they are more likely to experiment with new technologies. Conversely, organizations that desperately need to develop learning capacity will probably find it more difficult to implement the necessary technologies. Figure 2 portrays this reciprocal relationship between the two research streams.

---Insert Figure 2 about here---

We begin our review with a discussion of the concept of organizational learning, offering a specific definition of organizational learning as well reviewing the alternative methods for measuring learning in empirical research. We then review the two emerging streams of empirical work on information technology and organizational learning: first, studies that apply organizational learning concepts to understand the process of implementing information technology in organizations; and second, studies that treat information technology as a mechanism to increase organizational learning. From these reviews, we develop specific conclusions and directions for future research.

### **Organizational Learning: Meaning and Measurement**

In recent years, the concept of organizational learning has enjoyed a renaissance among both academics and practitioners seeking to improve organizations. Early proponents (e.g., Argyris and Schön, 1978) found their ideas largely confined to the periphery of management

thought during the 1980s, but the 1990s witnessed a rebirth of interest. The current renaissance is evident in the creation of a journal about organizational learning (*The Learning Organization*) as well as in the devotion of special issues of several journals to the topic (e.g., *Organization Science*, 1991; *Organizational Dynamics*, 1993; *Accounting, Management and Information Technologies*, 1995; *Journal of Organizational Change Management*, 1996). The appearance of several major review articles is testimony to organizational learning's growing stature in the research community (see Crossan, Lane, and White, 1999; Dodgson, 1993; Fiol and Lyles, 1985; Huber, 1991; Jones, 1995; Levitt and March, 1988; Miner and Mezias, 1996). Moreover, a large number of articles in professional periodicals describing the design and management of learning organizations attests to the popularity of organizational learning and knowledge management among practitioners. New theories of knowledge creation have become prominent (Nonaka, 1994; Raelin, 1997), and formal knowledge management programs have been undertaken in many companies (Davenport, DeLong, and Beers, 1998). As we head into the twenty-first century, therefore, organizational learning promises to be a dominant perspective with influence on both organizational research and management practice (Argyris and Schön, 1996).

The study of organizational learning considers organizations to be cognitive entities, capable of observing their own actions, experimenting to discover the effects of alternative actions, and modifying their actions to improve performance (Fiol and Lyles, 1985). Organizational improvement is dependent upon revisions to organizational memory, an analogy used to describe the understandings shared by members of an organization, especially the cognitive maps that connect organizational actions to outcomes (Anand, Manz and Glick, 1998; Duncan and Weiss, 1979; Walsh and Ungson, 1991). However, where organizational memory is well established, residual memory may prevent new learning unless there are established norms

for experimentation and change. Changes in organizational memory cannot be accomplished by the simple exchange of old knowledge for new because it is difficult for organizations to unlearn what they already know (Bowker, 1997; Hedberg, 1981; Klein, 1989). Moreover, organizational memory may be widely distributed throughout a complex web of internal and external connections involving humans and technologies (Anand *et al.*, 1998; Hutchins, 1995; Weick and Roberts, 1993). Memory distribution increases the problem of locating and exchanging specific elements of organizational memory.

Despite its popularity, recent reviews of the field have been critical of organizational learning's splintered research tradition (Crossan *et al.*, 1999; Huber, 1991). Huber assessed the situation as one in which "there is little cross-fertilization or synthesis of work done by different research groups or on different but related aspects of organizational learning" (1991, p. 107). Dodgson (1993) traced this problem to the generic nature of learning, showing it to be a focus in scholarly fields as diverse as psychology, economics, and organizational science. Crossan and her colleagues concurred that "different researchers have applied the concept of organizational learning, or at least the terminology, to different domains" (1999: p. 522). Because organizational learning has such diverse origins, it is unlikely that a uniform understanding of organizational learning will ever be shared widely. Therefore, it is essential for researchers to identify their own conceptual foundations and to specify their basic definitions and assumptions about organizational learning. More complete disclosure of one's particular position enables readers to assess one's contributions more accurately and to integrate arguments across multiple research initiatives.

## Defining Organizational Learning

Few phrases have entered the language of organization science with less apparent concern for establishing a common definition than *organizational learning*. The primary difficulty in reaching a useful definition is to distinguish the consequences of organizational learning from the learning process. On the one hand, the definitions proposed by Argyris and Schön (1978) and Fiol and Lyles (1985) emphasize the contribution of learning to enhance organizational effectiveness. On the other hand, Huber defined organizational learning as a change in the range of an organization's potential behaviors (1991, p. 89), which may or may not contribute to enhanced effectiveness. For Huber, an organization may acquire the knowledge needed to perform differently without actually demonstrating that potential. It is clearly valuable to examine both the consequences of learning and the processes that produce those consequences, and definitions of organizational learning tend to emphasize either one or the other.

In this paper, we define organizational learning as *an organizational process, both intentional and unintentional, enabling the acquisition of, access to, and revision of organizational memory, thereby providing direction to organizational action*. The key characteristics of this definition deserve attention. First, we view organizational learning as an *organizational* process to distinguish it from learning that might occur at other levels of social analysis, such as the individual, group, or interorganizational network. Although recent treatments of organizational learning emphasize the interactions among learning at multiple levels of analysis (Crossan *et al*, 1999), we confine our definition to the organizational level. Second, organizational learning is a *process*, not a configuration of structural components. While prescriptions for the design of learning organizations often emphasize nonhierarchical, team-



based structures, the learning process can occur within a variety of structural arrangements (Wishart, Elam and Robey, 1996). Third, we consider organizational learning to be both *intentional* and *unintentional*. Whether guided by intended action or not, learning may occur. Fourth, our definition gives a central role to *organizational memory*, a general term that implies that knowledge may be stored in a variety of repositories, both human and artifact (Anand *et al.*, 1998; Walsh and Ungson, 1991). Organizational memory includes shared understandings of an organization's identity (Fiol, 1994), the mental models that represent the organization's theories-in-use (Levitt and March, 1988; Miller, 1993), and both cognitive and behavioral routines (Cohen, 1991). Finally, we consider the organizational learning process to be undertaken to guide *organizational action*. Through acquired knowledge, an organization increases its repertoire for action.<sup>1</sup>

From this discussion, it can be concluded that learning and action are related, but that either enhanced or diminished effectiveness may result from organizational learning. In other words, learning does not always imply enhanced effectiveness. Organizations may learn superstitiously, or they may learn inappropriate behaviors vicariously from other organizations. Organizations may also develop "competency traps," in which knowledge gained from past successes is incorrectly applied to present problems (Levitt and March, 1988; Miller, 1993). While the normative thrust of the literature on organizational learning tends to frame learning as a positive force, which it can be, recognition must also be given to such "learning disabilities" that result in negative consequences for the organization.

---

<sup>1</sup> Our definition does not address the relative pace of organizational learning, that is, whether learning occurs incrementally or through radical, discontinuous change. A discussion of this issue is available in Argyris (1996).

## Measurement of Learning

*Outcome measures.* Treating organizational learning as a process with observable consequences suggests two approaches to the measurement of learning. The first approach is to measure *outcomes* of organizational actions and to infer learning from changes in outcomes over time. The derivation of learning curves is the most common application of the outcome approach. For example, Argote, Beckman and Epple (1990) studied the productivity of U.S. shipyards commissioned to build Liberty Ships during World War II, showing that learning was acquired both from experience and by transfer of knowledge from other shipyards. Yards that began production earlier relied primarily upon their own experiences, whereas yards beginning production later could learn more effectively from other yards. In another study, Epple, Argote and Devadas (1991) studied the transfer of learning outcomes between shifts in a single manufacturing plant. Again, learning was inferred from changes in production rates, and conclusions were drawn about the relative effectiveness of learning from experience versus acquired knowledge. Subsequent studies have confirmed and extended these findings (e.g., Epple, Argote and Murphy, 1996). A final example is provided by Saraswat and Gorgone (1990), who used learning curve analysis to study the installation of packaged software across multiple client sites. In their research, learning was found to be dependent upon the type of hardware on which the packaged software was implemented.

*Process measures.* Although learning curve studies rigorously estimate the rate of learning by fitting temporal data to functional forms, they do not observe the learning process directly. Indeed, the historical data that are most useful for constructing a learning curve provide no direct insight into organizational processes whereby knowledge is acquired and used. Unfortunately, few studies have attempted a direct examination of the learning process. More

commonly, researchers use the concepts of organizational learning to interpret data describing organizational actions *after* data have been collected. For example, case studies may provide rich descriptions of events leading to successful action, and researchers may conclude that organizational learning has occurred (e.g., Caron, Jarvenpaa and Stoddard, 1994; Yetton, Johnston and Craig, 1994). This practice is acceptable in exploratory studies where phenomena are not well understood and where theory provides little foundation for guiding empirical work. However, researchers will ultimately need to adopt research designs in which measures of the learning process are established in advance rather than *post hoc*. At a minimum, this requires researchers to specify the types of events that constitute the learning process, as distinct from other processes that may simultaneously occur.

One approach to developing a measure of the organizational learning process is provided by Crossan and Hurland (1997). These researchers developed a questionnaire designed to measure learning at the individual, group, and organizational levels as well as the flows among these levels. However, close examination of Crossan and Hurland's questionnaire reveals more attention to learning outcomes than learning activities. In general, it may be too much to expect conventional questionnaire items to capture the events implicit in a learning process, even if they are administered at different points in time.

Measurement of the organizational learning process should rather be guided by theoretical constructs that describe activities occurring over time. For example, Crossan *et al.*'s (1999) framework includes four main events: *intuiting*, the preconscious recognition of the possibilities inherent in a personal experience; *interpreting*, the explanation of an idea to oneself and to others; *integrating*, the developing of a shared understanding and coordinated action among individuals; and *institutionalizing*, the process of ensuring that actions are made routine.

By directing attention to events across time, this framework may guide measurement of the organizational learning processes.

*Combining outcome and process measures.* It would seem beneficial to combine the outcome and process approaches, thereby establishing a stronger association between actions that are construed as learning and the outcomes of learning. The research method that most commonly incorporates both process and outcome is simulation (e.g., March, 1991; Ouksel, Mihavics and Chalos, 1997; Stäbler and Ewaldt, 1998). However, simulations only achieve their knowledge of process because the researcher has created a mathematical model to represent it. The learning process is both described and deliberately manipulated to study the effects of alternative processes on outcomes. Obviously, simulation studies are limited in their capacity to represent events in the real world, although they have generated valuable insights in many cases.

The concerns about meaning and measurement apply to all research on organizational learning, including those that are the focus of this review. We preface our review with these general points in order to clarify the domain within which research on organizational learning and information technology operates. The appeal and popularity of organizational learning must be weighed against its commonly experienced difficulties. By clarifying our definition, and by raising the measurement issue, our review and recommendations may proceed with due caution.

### **Organizational Learning about Information Technology**

One emerging stream of empirical work uses organizational learning to understand the implementation and use of information technology in organizations. Driving this inquiry is the realization that information technology frequently yields disappointing results: low payoffs, financial losses, dissatisfied users, and no increase in organizational effectiveness. However,

such failures are not experienced uniformly; a growing number of studies have documented the sharply contrasting consequences experienced by comparable organizations employing identical technologies (Robey and Boudreau, 1999). The relative ability of organizations to learn how to use the same technologies may be one way to account for such differences. The present section reviews and assesses the empirical contributions in this research stream.

### **The Role of Experience**

How do organizations learn to employ information technologies effectively? A good deal of evidence indicates that an organization's own experience provides a base of knowledge for guiding current actions. Case studies provide the greatest detail on the role of experience. For example, Cigna Corporation's experiences with business process reengineering have been reported as a case of learning from both successful and unsuccessful projects (Caron, *et al.*, 1994). By adopting an incremental approach to implementing reengineering projects, Cigna was able to apply knowledge gained from earlier projects to subsequent projects. Another example of learning from experience is the successful use of information technology by the architectural firm, Flower and Samios (Yetton *et al.*, 1994). For Flower and Samios, success was achieved almost completely through immediate experience, obtained "on the spot," as computer-based architectural tools were being implemented. Rather than beginning with the formulation of a strategic plan, the company began by adopting new technology, which then required the staff to master it rapidly and to disseminate their acquired knowledge throughout the firm. In a short time, the technology became successfully integrated with the core business processes of the firm. Unlike Cigna, which chose a phased approach in order to generate experience, Flower and

Samios drew from its immediate experiences in a solitary technology initiative. Both cases, however, provide evidence of the benefit of experience to achieving implementation success.

While the preceding case studies illustrate positive outcomes of learning from experience, case studies may also illustrate the difficulty of learning from experience. Robey and Newman (1996) invoked organizational learning retrospectively to make sense of the recurring failure of Centco (a pseudonym) to develop and implement a materials management system. Despite making costly mistakes, Centco manifested a persistent pattern of dependence on unproven software from outside vendors and failure to resolve an ongoing conflict between users and internal systems professionals. The case is valuable because it spans 15 years of development history, permitting the detection and interpretation of repeating patterns of action. Although eventually Centco reversed the pattern of failure and implemented parts of the system, it is unclear why past experience was ignored and why dysfunctional patterns went uncorrected for so many years. Ang, Thong and Yap (1997) reported similar findings in a case study of an insurance company in Singapore.

Research evidence also shows the importance of experience with technologies that are similar to those currently being adopted. Using the tax preparation and filing industry as their setting, Martins and Kambil (1999) conducted a survey to see how managers' experiences with a specific strategic information technology influenced their interpretation of new applications and systems. The authors showed that managers with more favorable experiences with information technology tended to interpret new information technologies as opportunities and had greater expectations of profit increases from using them. These results emphasize the importance of managers' prior experiences when predicting their receptivity to new kinds of information technologies.

Thus, one can conclude from the retrospective interpretations by researchers of both detailed case reports and survey research that an organization's experience with information technology may affect subsequent implementation success. Such a conclusion is wholly consistent with any conception of learning and consistent with studies examining the sources of organizational knowledge (Argote *et al.*, 1990; Epple *et al.*, 1991). However, these studies do not account for instances where organizations fail to learn from their own experience (e.g., Robey and Newman, 1996). Clearly, the learning process is more complex than simply adjusting action based on experience.

A fundamental problem with experience is that recent experience must always vie with older experience. Older experience appears to be disproportionately powerful, so that in cases where a particular technology has been successful, organizations may persist in its use long after it has ceased to be effective (Gill, 1995). Such competency traps occur when favorable performance with a procedure or technology leads an organization to accumulate more experience with it, thus inhibiting the use of other procedures or technologies that could be more effective (Levitt and March, 1988). In many cases, old experiences may have so shaped organizational memory that it is difficult for new experience to change the contours of organizational action. Although knowledge learned through experience will probably always guide future action, some older knowledge may be irrelevant to contemporary problems and may create a barrier to the acquisition of more relevant knowledge based on more recent experience. The group of studies reviewed next addresses the ability of organizations to overcome these and other knowledge barriers.

## **Overcoming Knowledge Barriers**

*Formal training.* One reason why organizations do not uniquely learn from experience is the presence of knowledge barriers. Much of the research relevant to implementing information technology deals directly or indirectly with overcoming barriers to acquiring new knowledge. One obvious approach, directly related to learning, is a formal training program. Following Argyris and Schön's (1978) lead, Salaway (1987) developed and evaluated a training program in which she promoted the use of a "Model 2" approach to improve organizational learning through the enhancement of communication between users and systems analysts. In contrast with the error-prone, defensive communication implied by a Model 1 approach, a Model 2 approach facilitates the exchange of more authentic information of higher quality and produces more effective organizational action. Salaway demonstrated that a Model 2 approach to communication could be learned by systems professionals in a formal training program. Although it validates the relevance of formal training, Salaway's research is a better example of individual learning than organizational learning. The acquisition of Model 2 skills by the systems professionals in her sample did not ensure that more authentic communication was transferred to the organizational contexts where these individuals worked.

*Action research.* Salaway's (1987) formal training program was undertaken in the spirit of action research. Indeed, according to Argyris and Schön (1996), action research is one of the primary instruments for increasing organizational learning. In action research, researchers try to improve practice through systematic feedback of their research observations to a client organization. "Scholarly consultants" must be dedicated to empirical inquiry, to theory testing, and to a rigorous evaluation of the consequences of the theories they implement (Argyris, 1996). For example, Bostrom (1989; Kaiser and Bostrom, 1982) employed techniques in a university



setting for improving the conduct of formal meetings involving system users and developers. Also, Baskerville and Stage (1996) used action research to develop a new approach to managing risks in projects involving prototyping. Because prototyping depends heavily upon communication and consensus between users and developers, risks are traditionally hard to assess or control. By developing a model for risk mitigation, Baskerville and Stage enabled appropriate strategies for controlling the risks of prototype development, thereby extending the promised benefits of prototyping to a wider range of projects. Like formal training, action research offers a structured look at experience and directs actors toward choices likely to improve the chances that advanced technologies will be implemented successfully.

Argyris and Schön (1996) warned that the actions taken to promote organizational learning, such as the use of formal training programs and action research, may actually inhibit deeper learning. This "learning paradox" reflects the difficulty of adopting the Model 2 approach in most organizations, where authentic communication and feedback are not the norm. This effect is similar to the "performance paradox" wherein managers ignore or contradict the knowledge they possess to improve organizational performance (Cohen, 1998). The failure to learn from experience, especially from unambiguously negative experience, is a serious problem in systems development because the costs of failure are so high (Lyytinen and Robey, 1999).

*Social Context of Learning.* In many organizations, the learning paradox is less apparent because improvement is increased through learning that is not connected to formal learning efforts. Rather, knowledge barriers are overcome through learning that emerges informally from the social context of work. For example, George, Iacono and Kling (1995) demonstrated the importance of the social context in their longitudinal study of desktop computing. They speculated that different work groups would provide different types of learning environments,

some that encouraged learning and others that discouraged it. They found that factors such as occupational status (professional vs. clerical) and implementation practices (grassroots vs. top-down) influenced a work group's learning. For example, the professional workers learned through their own grassroots computing efforts and resisted the more formal learning opportunities offered by the firm's system professionals. George and his colleagues concluded that learning depends on the social context of work, it often occurs without formal approval, and it may operate independently of formal learning policies.

Another example of how the social context of learning affects knowledge barriers is Orlikowski's (1996) study of context-specific improvisations in work practices, undertaken by technical support employees in a large U.S. software firm. Despite the absence of explicit intentions, the improvised responses to social context produced a transformation in work practices, organizing structures, and coordination mechanisms. Orlikowski's findings are consistent with Sahay and Robey's (1996) findings that social context conditioned the spread of knowledge and accounted for organizational learning about geographic information systems in government organizations. They are also consistent with Goodman and Darr's (1998) findings about the adoption and use of a system explicitly designed to support organizational learning.

The social context of learning was also investigated by Romm, Pliskin and Rifkin (1996), who described the introduction of electronic mail (email) in a university. Although they observed that the organizational processes of information acquisition, distribution, and interpretation were improved after email was introduced, they also reported political uses of email, notably a rebellion against top administration. Obviously, learning had occurred, but the project was not considered successful because of its political repercussions. Such studies of the social context of

implementation offer insight into the interplay between organizational learning and other social processes, such as politics, that have been associated with implementation for many years.

These findings from field studies are supported in at least one laboratory study, which also investigated the role of social context on learning about information technology. Lim, Ward, and Benbasat (1997) studied the effects of self-discovery and co-discovery learning approaches on the ability of experimental subjects to learn a computer task. The co-discovery treatment group learned more, indicating that learning was better accomplished as a social activity than as an individual task.

*Learning from others.* In addition to the internal organizational means for overcoming knowledge barriers, external sources of knowledge have been shown to play an important role. Organizations that have already learned to use information technology effectively can provide vicarious learning opportunities for other organizations that choose to imitate them. “Benchmarking” is a popular means of learning the best practices used by other companies, including competitors (Mann, Samson, and Dow, 1998). Although imitation often carries the risk that knowledge will not transfer from one context to the next, it is one form of vicarious learning that is frequently pursued.

A second way to learn from others is to engage intermediaries in the learning process. In a broad historical study of the adoption of business computing, Attewell (1992) argued that mediating institutions materialized to create and accumulate technical knowledge regarding computing technologies. That is, computer service providers fulfilled computing needs for many companies that were unable to meet the knowledge demands associated with in-house computing. The use of intermediaries continues to be a useful way for organizations to overcome knowledge barriers. For example, many companies depend upon telecommunications providers

to overcome corporate knowledge barriers to Internet use. Consulting also remains a major option for organizations to learn without developing internal knowledge capabilities.<sup>2</sup>

Intermediary companies themselves gain valuable knowledge from their interaction with multiple client organizations. Intermediaries accumulate local knowledge as they help other organizations to overcome knowledge barriers. Through both failed and successful attempts to implement technologies for their clients, intermediaries create generic knowledge that may be useful to all clients. Fleck (1994) illustrated the importance of learning by intermediaries in a case study in which a computer vendor failed to implement its standard material requirements planning package for a client. Even though the implementation itself was not successful, the intermediary acquired valuable experience that led to modification of the package. Subsequent implementations of the package with other clients, therefore, promised to be more successful due to the learning that the vendor firm had acquired. Thus, organizational learning *by* intermediaries is closely linked to learning *through* intermediaries.

### **Dynamics of Learning**

In addition to his findings about intermediaries, Attewell (1992) raised an important issue concerning the dynamics of organizational learning. He suggested that firms are likely to delay the in-house adoption of information technologies until they obtain sufficient know-how to implement and operate them. Before firms become ready, mediating institutions provide technical know-how regarding the given technologies. Organizations that will be among the first to separate from such mediating institutions are those having a flatter learning curve, either because much of the required know-how already exists within the organization or because such

---

<sup>2</sup> Learning through intermediaries should be distinguished from outsourcing, in which an organization contracts for goods and/or services with external suppliers. Although services obtained from outside may have a large knowledge

knowledge can be acquired more easily or more economically (Fichman and Kemerer, 1997). Eventually, for most firms, the locus of knowledge changes from mediating institutions to in-house services. In-house capabilities for developing information technologies better accommodate local contingencies than the more generic knowledge available from intermediaries. Thus, in-house knowledge capabilities evolve dynamically as a result of using intermediaries earlier in a firm's history.

Once knowledge barriers are overcome sufficiently to move computing capabilities in house, the dynamics of organizational learning continue. Research suggests that organizations modify their uses of information technology as they gain experience with them, but that progressive modifications and incremental improvements are not spread evenly over time (Gaimon, 1997). For example, Tyre and Orlikowski (1994) found that technological adaptations were most likely to occur at two points: either immediately after technologies were introduced or later in response to disruptive events. These "windows of opportunity" are, apparently, periods in which learning occurs based on feedback from recent experience. The windows of opportunity close quickly, however, suggesting that organizational knowledge about information technology stabilizes quickly after new technologies are introduced or after later disruptions. Such stabilization may account for the failure to learn from experience (Lyytinen and Robey, 1999).

## **Conclusions**

The review of literature supports four specific conclusions about the way in which organizations learn to implement information technologies. First, learning is closely linked to experience. Past experience with information technology can improve future implementation if organizations consciously reflect and learn from it. But it is also possible for such experience to

---

component, it would be unusual for that knowledge component to bring significant competitive advantage.

be ignored and for implementation problems to persist. Both older and more recent experience can be useful although it is difficult to judge, from the research reviewed, the relative value of each kind of experience. In some cases, older experience provides useful knowledge for implementing technologies, but in other cases old experience contributes to competency traps that impede new learning. Also, we have seen cases where firms depend most heavily on immediate past experience to implement information technologies effectively. Thus, although experience is intimately tied to learning, it is unclear how organizations sort through their experiences to produce knowledge deemed valuable to implementation.

Second, learning may not only be enhanced through formal activities such as training and action research, but also through activities that are situated within the context of work practices. Formal activities can be effective ways to overcome knowledge barriers, but many organizations may not be ready to conform to new norms of openness and authenticity prescribed by formal change agents. Consequently, organizational learning that emerges informally from practice may be more effective than formal learning.

Third, knowledge barriers can be overcome by learning from other organizations and from intermediaries such as consultants and service providers. Intermediaries are a particularly valuable source of knowledge because they acquire experience from working with many client organizations. Over time, organizations may become less dependent on intermediaries as they develop their own capabilities with information technologies. Although there may be little strategic value in the knowledge gained from intermediaries, using intermediaries may allow an organization to gain sufficient experience to move information technologies in house at a later time.

Fourth, research reveals the importance of dynamics in the learning process. Organizations appear to adapt to technologies during brief periods following their introduction or in response to later breakdowns or disruptions. Once these windows of opportunity are closed, learning is likely to stop as new routines become established.

Together, these conclusions potentially account for the reasons why some organizations are able to implement and use advanced information technologies with relative ease while others struggle. Differences in the technologies themselves appear less consequential; learning potentially accounts for radically different outcomes across organizations that have acquired the same technologies (Robey and Boudreau, 1999). Clearly, information technologies are subject to complex social processes as they are implemented and used in organizations; they are not plugged in and played without the involvement of numerous actors over significant periods of time. While other social processes, such as politics, have been used to explain how organizations implement information technology, organizational learning offers valuable insights into the role of past experience, different sources of knowledge, and the dynamics of change.

### **Information Technology Designed to Support Organizational Learning**

The second emerging stream of research on information technology and organizational learning seeks to guide the application of technologies that support organizational learning. On the one hand, such research augments the conventional prescriptions for designing learning organizations by offering advanced technologies to enhance organizational memory and to facilitate communication and discourse among members of the organization. While these functions can be performed without supporting applications of information technology, technology can allow these functions to be performed more effectively. On the other hand, research has also revealed that information technologies may unwittingly disable organizational

learning by inducing dependence on inflexible, formal systems. In the present section, we review studies in which information technology has either an enabling or a disabling role in organizational learning.<sup>3</sup>

### **Information Technology as an Enabler of Organizational Learning**

*Systems designed to enhance organizational memory.* As defined earlier, organizational memory is a broad concept that includes a wide variety of forms of knowledge. Walsh and Ungson (1991) described five "bins" for storing the contents of organizational memory: individuals, culture, transformations, structures, and ecology. While Walsh and Ungson's concept draws important attention to the wide range of retention facilities available for organizational memory, it does not carefully distinguish between human and artifact facilities. Curiously, they limit their treatment of information technologies to "memory aids" within the category of "individual retention bins" (p. 63). Given its expanded capabilities, information technology now has greater potential to support organizational learning through the capture, representation, storage and retrieval of structured data, diagrams, models, text, and images in electronic databases (Anand et al., 1998; Davenport *et al.*, 1998). Such "organizational memory information systems" can more effectively support organizational memory than systems that are not expressly designed for that purpose. Three issues in the design of such systems have been addressed in the research literature: *conceptual design, knowledge representation, and retrieval and use.*

**Conceptual design.** Research on the conceptual design of organizational memory information systems proceeds by breaking organizational memory into its associated

---

<sup>3</sup> Many of the reports cited in this section adopt research methodologies designed to improve design concepts through formal methods and analyses. These studies do not employ the empirical methods associated with an



subprocesses. For example, Stein and Zwass (1995) identified the processes of acquisition, retention, maintenance, search and retrieval as "mnemonic functions" that comprise the foundations for the system illustrated in Figure 3. The linkages among functions and their relationship to storage repositories form the conceptual design, which can then be supported by particular applications of information technology. Stein and Zwass reviewed a number of specific applications designed to support one or more of the processes in Figure 3, thereby showing how disparate knowledge-handling technologies conceptually fit together to enhance organizational memory and organizational learning. Examples of these applications include hypertext and hypermedia technologies, expert systems, and case-based reasoning systems. These have been applied to tasks such as providing access to richly described documents, preserving the historical evolution of product design discussions, and providing groups with accessible memory across multiple projects (Stein and Zwass, 1995). The value of a conceptual design is to identify an appropriate role for specific applications within an integrated design.

---Insert Figure 3 about here---

Ramesh (1997) has developed a comparable, yet more specific conceptual design to guide the design of organizational memory information systems in large software development efforts. This conceptual design guided the development of a prototype for an issue-based information system to capture the detailed rationale behind decisions made in requirements engineering (Ramesh and Dhar, 1992). By tracking group processes and decisions, this system constituted an important component of organizational memory for a software development group.

---

“explanatory” research paradigm. However, by virtue of their contribution to knowledge about design, they qualify as research studies and are rightfully included in our review.

Wang (1999) extended research on conceptual design by recognizing that different situations may call for different organizational memory systems and therefore require a specialized modeling methodology. Wang's proposed methodology extended Stein and Zwass' (1995) framework by developing an object-oriented modeling method specifically for the analysis and design of organizational memory information systems. Using Stein and Zwass' conceptual design as a guide, Wang identified five components: documents, episodes, cognizances, goals, and mnemonic instruments. He developed a method for diagramming these five components and integrated the five components into a more comprehensive model. By providing a component framework that can be modeled using an object-oriented method and nomenclature, Wang contributed one of the first analysis and design methods for organizational memory information systems. Such methods could be fit within an overall development scenario for the design of organizational memory systems (e.g., Wijnhoven, 1999).

**Knowledge representation.** An additional focus of organizational memory systems research is knowledge representation. Ramesh's (1997) conceptual design for supporting organizational memory is an example that focuses on capturing multiple representations of organizational knowledge. The design includes flexible capture and easy coupling of both structured data (e.g., traditional database records) and unstructured data (e.g., deliberations among team members). The data captured includes:

- what information is represented
- how this information is created, represented by both formal and informal means
- who are the stakeholders that played roles in its creation, maintenance and use
- when this information was captured, modified and evolved
- where it is represented
- why a certain memory component was created or evolved (Ramesh, 1997: p. 325).

In addition, formal models of the unstructured data can be maintained to “facilitate easy access to these components, and enable automated reasoning about those characteristics”

(Ramesh, 1997: p. 327). By design, the translation of unstructured data into the formal model's general symbols and concept maps results in a loss of data richness, but the form of the original data can be maintained and indexed to the formal model.

Yap and Bjørn-Andersen (1998) described a practical application of three-dimensional knowledge representation in an international engineering firm's (AVP Anhydro) global marketing operations. By creating equal global access to rich forms of product knowledge, represented in three dimensions through the supporting information technologies, AVP Anhydro was able to "enrich knowledge representations, strengthen the nexus of corporate knowledge, and effectively convey complex technical knowledge throughout its global organization" (Yap and Bjørn-Andersen, 1998: 274). AVP Anhydro's capacity to increase organizational learning through conventional means was limited because it functioned as a global virtual organization. However, the creation of a virtual nexus for visual knowledge representations provided universal access to complex technical knowledge about the company's products.

**Retrieval and use.** The third research issue addressed in the organizational memory information systems literature is the automation of data retrieval and use. Systems have been designed to retrieve and use data in organizational memory directly, without human intervention. To facilitate retrieval, structure may be created by isolating a task in which data formats are reasonably predictable or manageable. For example, Elofson and Konsynski (1993) designed a system to allow decisions within an environmental scanning process to be captured in an organization's memory. Within this narrowly defined task, work processes and decision trees from individual environmental scanners are captured in a database. Because the environmental scanning process is routine, structured data may be used as input for intelligent agents, which replicate prior scanning procedures to solve recurring problems. Additionally, agents

demonstrate where pre-existing solutions do not exist and alert the organization to the need for additional learning.

Zhu, Prietula and Hsu (1997) provide another example of automated data retrieval and use. They described an artificial intelligence system, the Dispatcher-Soar, consisting of manually captured decision rules that reflect expert human judgments. The formalization of the rules within the automated system enables their reuse and application to new problems. Additionally, the system can recognize new problems and create alternative solutions using existing memory patterns. Based on the success experienced with new alternatives, the system can learn how to improve performance on the same problem and how to solve more complex problems.

El Sawy and Bowles (1997) reported a comprehensive study of the implementation of an organizational memory information system, which showed measurable benefits to the adopting organization. The TechConnect system was developed specifically for customer support at Storage Dimensions, a manufacturer of computer storage products. The system has a structured data interface that captures problems, classifies them, reviews potential solutions, weighs the usefulness of each solution with regard to the original problem, and generates new solutions if needed. TechConnect has a specialized search engine that finds and evaluates potential solutions to customer problems based on historical data. As a result of implementing TechConnect, Storage Dimensions realized tangible gains including reduced problem resolution times greater than 75 percent. Moreover, the system enabled the company to understand patterns of customer problems and to take proactive measures that reduced the number of support calls by more than 75 percent, among other reported gains.

*Systems to support communication and discourse.* The enhancement of organizational memory through supporting information technologies does not directly include an important

aspect of organizational learning: the communication and discourse among members of an organization. Communication among members is essential to organizational learning because members must both contribute to and share the contents stored in various memory bins, and they must communicate in order to subject existing memory to scrutiny and experiential tests. Applications of information technology expressly designed for these purposes include some group support systems and more advanced forms of collaborative tools that support organization-wide discourse (e.g., Lotus Notes, a widely used application for supporting collaboration). These systems may support organizational learning by providing communication links among members and by storing historical records of decisions. As members gain access to knowledge housed in such electronic archives, more usable organizational memory is created. By promoting discourse, these applications expand an organization's "information space" where greater numbers of individuals, even in remote locations, can contribute to and draw from a shared organizational memory (Karsten, 1999).

Systems to support communication and discourse differ from ordinary group support systems. Hine and Goul (1998) distinguished between systems that support group processes and systems that support organizational learning. Organizational learning systems include features that automatically detect and surface disagreements and conflicts in strategic decision models. Hine and Goul's system contains a specialized knowledge base, which receives and responds to managers' structured queries and which catalogues users' conclusions and decisions. Managers evaluating similar external information have their evaluations cross-evaluated by the system, which can then identify both consensus and conflict. When a conflict is identified, the system calls an electronic "meeting" among managers with differing interpretations and prompts them to discuss the multiple evaluations and to communicate about their differences. The toolkit thus

facilitates organizational learning by collecting structured data, automating data retrieval, and facilitating communication to create new interpretations of data.

Notions of shared or distributed cognition guide recent work in the design of systems to support discourse and communication. Such systems provide a bridge between individual and organizational learning. For example, Boland, Tenkasi and Te'eni (1994) developed a system, named Spider, to support organizational learning "by enabling individuals to make rich representations of their understanding, reflect upon those representations, engage in dialogue about them with others, and use them to inform action" (1994: p. 457). With Spider, users can represent their interpretations in the form of cognitive maps that accommodate both textual and tabular data. The system supports multiple interpretations of the same problems, enabling users to reconcile their interpretations of situations with the interpretations of other members of an organization.

While group support systems are designed to enable organizational learning by supporting distributed cognition and shared understandings, several studies suggest that in actual use, such systems acquire different meanings and interpretations in different parts of the organization. For example, Orlikowski and Gash (1994) found that managers and technologists had sharply divergent frames of reference for understanding Lotus Notes. Karsten (1995) found similar variations in individual interpretations of Lotus Notes across three case studies. Because the interpretations of technology designed to support communication and discourse differ within organizations, the use of such technologies is unlikely to result in a uniformly shared organizational memory. However, by providing a vehicle for communication about those differences, collaborative technologies may support debates and discussions that bring assumptions to the surface and propose alternative courses of action. By supporting discourse

that originates in different frames of reference, these technologies potentially support the organizational learning process. However, they do not necessarily lead more collaboration because they may not fit organizational norms or the expectations of members (Vandenbosch and Ginzberg, 1996-97).

### **Information Technology as a Disabler of Organizational Learning**

Recognition of the role of information technology in enabling learning has not blinded researchers to the potential of information technology to disable organizational learning. The primary concern addressed in a group of studies is that organizations may become overly dependent on formal systems and thereby lose their appreciation for less formal representations of organizational memory, such as those residing in the heads of experienced employees. The deeper that intelligent routines become embedded in computer systems, the less likely they will be inspected and revised when business needs change. Thus, information technology may disable organizational learning by supporting rigid systems that are not adaptable to changing conditions of use.

A small number of case studies demonstrate the disabling effects of information technology on organizational learning. Gill (1995) analyzed two well-known business cases (Mrs. Fields' Cookies and Batterymarch Financial Management) to illustrate these effects. In each company, the respective systems initially provided competitive advantage by automating important managerial functions and enabling radical transformations in organization structure. Over time, however, each firm experienced a decline in market share from which it did not recover. Gill explained the declines by noting that the information systems replaced individuals (e.g., middle managers) whose duties had included scanning the environment to detect market

and regulatory changes. While the information technology capably processed the structured information as it always had, the systems provided no capacity for gathering and interpreting unstructured information. As a result, the organizations were unaware of the need to change their practices and the systems that supported them. Both lost market share and did not regain their former economic luster.

This basic pattern was also reported in a case study in which an energy-auditing process was automated (Pentland, 1995). By formalizing the task of producing an audit report, information technology essentially removed the need for users to know how to perform an audit. That knowledge was replaced by an understanding of how to manipulate the information systems to generate desired output in spite of the technology. The disabling effects of information technology were also evident in Orlikowski's (1992) study of CASE tools used in systems consulting. CASE tools represented a form of organizational memory that standardized the work processes of system developers into routines. While intended to increase the effectiveness of consultants by embedding rules within software, the CASE tool also created a "trained incapacity" to perform systems consulting in other ways. In each of these case studies, information technology disabled organizational learning by inducing actors to forget what they once knew and by failing to signal needed changes in technical systems supporting their tasks.

Although embedding processes into automated systems can disable organizational learning, these effects can be mitigated. Käkölä (1995b) described a "white-box" approach to system design, intended to counteract the negative effects of freezing knowledge about work domains within inaccessible software routines. This approach promotes the idea of creating applications that are transparent (white) to the user instead of burying knowledge within an inaccessible (black) box. Human agents may view the logical structure through a graphic



interface that exposes the context of each function within the overall process, allowing inspection of the logic and data sources employed by the technologies. Organizational memory embedded in the software can therefore be audited before it is accepted as the basis for organizational decisions. In later work, Käkölä and Koota (1999a; 1999b) extended the concept of white-box design in a conceptual design for a “dual information system.”

## **Conclusions**

Research on information technology designed to support organizational learning produces three main conclusions. First, value is produced by the creation of conceptual designs for organizational memory information systems. The higher level abstractions provided by conceptual designs place existing technical applications within a larger framework, wherein their contribution to organizational memory and learning can be understood. Conceptual designs also provide a guide the development of new systems. The work of Stein and Zwass (1995), Ramesh (1997), and Wang (1999) represents a starting point in this line of research.

Second, information technologies enhance organizational learning by increasing members’ communication and by supporting discourse among them. The advantages include greater access to organizational memory, especially from remote locations, and greater opportunity to test and challenge prevailing assumptions and routines. Supporting discourse implies more than providing electronic access to a centralized organizational memory; new organizational knowledge is also generated through discourse. Interpretive research shows how collaborative systems acquire different meanings depending on their organizational context of use. Thus, users operating in different contexts are likely to draw different meanings from

centralized information stores. Communication technologies can support an organization-wide discourse that questions static assumptions and creates new knowledge.

Third, information technologies may both enable and disable organizational learning. Systems that support learning by embedding routines into memory and storing historical information may be useful as long as the assumptions on which they are built do not become obsolete. When business conditions change, however, those technologies may constrain search for new information and mask the logic underlying “intelligent” routines. Overcoming the disabling effects of information technology may be aided by the concept of white-box designs and dual information systems, in which the underlying logic of a system is exposed to the user.

While only a limited amount of research can be presented to support these conclusions, it is clear that designing applications of information technology to support organizational learning has promise. Systems designed to support organizational learning aim to enhance organizational effectiveness in fundamental ways. Organizational memory can be actualized with information technology, and shared cognition can be encouraged through systems that link members together while providing access to structured and unstructured data.

### **Directions for Future Research**

This paper has reviewed and assessed the emerging literature on information technology and organizational learning. We conclude by identifying potentially profitable directions for future research in both of the main streams of work reviewed. Specifically, we address the prospect of bridging the paradigms used in the respective research streams, conducting research that recognizes the situated nature of organizational learning, designing information technology for distributed organizational memory, demonstrating effectiveness of organizational memory

information systems and other artifacts in practice, and looking for relevant research findings in related fields.

### **Bridging Research Paradigms**

As Figure 2 suggests, information technology may increase the capacity of organizations to learn and, simultaneously, learning capacity may affect the degree to which new technologies are adopted and used effectively. In the most optimistic scenario, these two effects reinforce each other: the capacity to learn is increased steadily through increased technology adoption and use. For many organizations, however, learning capacity may never increase due to the difficulties in adopting and using information technology. Consequently, many organizations may experience continued difficulty adopting the technologies necessary to compete in changing business environments. To the degree that research on information technology and organizational learning addresses only one half of the problem, it cannot guide practice as effectively.

Unfortunately, incomplete research agendas are likely to persist due to the differences in researchers' paradigms. Those examining research questions about how organizations may use technology more effectively draw primarily from a paradigm that values empirical explanations. The many case studies and surveys cited in our review are evidence of this paradigm in operation. By contrast, researchers seeking to develop conceptual designs and prototypes of technologies that can support learning draw from a paradigm of analytic research, most common in engineering and computer science. Here, the ultimate goal is the demonstration of improved performance by artifacts created in the research process. While both paradigms produce knowledge, they do so in different ways. Because research of any type requires specialized

training that is reinforced in research practices, it may seem unlikely that the gap between these paradigms can ever be bridged effectively.

However, the value gained from bridging these paradigms is likely to be worth the effort. In our review, few studies reveal the potential value of integration, but some do. The empirical studies of Lotus Notes users (Karsten, 1995; Orlikowski and Gash, 1994; Vandebosch and Ginzberg, 1996-97) provide valuable insight into patterns of actual use of artifacts that were designed for one purpose but that in practice were understood and used in diverse ways. Artifact designers have also displayed sensitivity to the need for learning technologies to actually be used (Käkölä, 1995a). As El Sawy and Bowles (1997) demonstrated, organizational memory technologies can have beneficial consequences for business performance, but the link between artifact features and performance needs to be demonstrated in research, not assumed. Likewise, studies of technology adoption need to understand important distinctions between different applications. The tendency of researchers to develop theoretical explanations that treat all types of information technology alike is an unfortunate simplification of reality. When examining the reasons why organizations learn and fail to learn, the nature of the technology itself may account for important differences in outcomes. For example, the similarity of technologies that have already been used by an organization to those it must try to learn has been shown to exert strong influence over successful adoption and use (Martins and Kambil, 1999).

If integration across research paradigms is ever to be achieved, we expect that it will begin by exposing scientists working in both domains to the work by those operating with different paradigms. To help this process begin, we have included work falling into both paradigms within a single review. While this does not achieve integration, it may promote greater appreciation and communication between the research traditions.

## **The Situated Nature of Organizational Learning**

Earlier in this review we described the learning paradox, in which formal programs for increasing organizational learning might be resisted despite their potential positive effects. One reason for resisting formal training is that adopters of information technology prefer to learn from trusted colleagues who understand the relevant details of the work as practiced. This type of learning is situated in practice rather than conveyed through formal means. Lave and Wenger (1991) use the term, situated learning, to describe the view that “learning is an integral and inseparable aspect of social practice” (p. 31). Thus, users of information technology are likely to learn about new technologies through learning that is situated in practice rather than learning from formal training programs. Because work practice differs fundamentally from the way that organizations describe their operations in manuals and training programs, situated learning should be regarded as an important, consequential process (Brown, 1998). Indeed, situated learning may provide benefits to the organization that are unattainable through other means. The relevant network of participants who share the same enterprise, i.e., a “community-of-practice,” may be effective in overcoming barriers to learning a particular application of information technology.

In Brown's (1998) study of the work practice at Xerox, for example, situated learning was specifically acknowledged in the author's call to leverage the different uses of Internet technology to support the organization's communities of practice. In another study involving Xerox, Orr (1996) used ethnographic methods to study the work of service technicians who maintained photocopiers. In a compelling account of situated learning, Orr described how technicians' work often differs from the methods specified in formal documentation provided by

management. Because documentation neither includes all the actions that technicians may potentially take nor always suggests an appropriate course of action, technicians could not and did not rely on such formal sources. Rather, technical knowledge was seen as a socially distributed resource, stored and diffused primarily through an oral culture. Tyre and von Hippel's (1997) study of factory settings suggests that the physical situation of work also affects organizational learning, but situated learning can also occur within virtual teams (Robey, Khoo, and Powers, forthcoming).

Future research employing the concept of situated learning can extend the research that we reviewed on the social context of learning. Communities of practice, and the learning process situated within them, offer a valuable theoretical framework for understanding how social context influences learning about new technology. This does not mean that research on formal training programs should be abandoned, but it does suggest a need to examine why they are often ignored in practice.

### **Information Technology for Distributed Organizational Memory**

The notion of learning situated in communities practice is related to the concept of distributed organizational memory. Much of the research on designing technologies to support organizational learning assumes that artifacts should comprise a substantial repository for memory. However, theories of transactive memory (Wegner, 1986), collective mind (Weick and Roberts, 1993), and distributed cognition (Hutchins, 1995) argue that organizational cognition is widely distributed among humans and artifacts, both internal and external to an organization (Anand *et al.*, 1998). Moreover, the performance of cognitive tasks by individuals invokes a complex system that "includes a web of coordination among the media and processes inside and

outside the individual task performers” (Hutchins, 1995: 289). Thus, learning in organizations depends partially on enabling technologies, but the use of technologies in practice may vary widely depending upon the specific task, the participants involved, and the contextual conditions faced. Proponents of distributed cognition argue that task performance is more reliable due to the redundancies and correction capabilities encompassed in the distributed system. Indeed, research on distributed cognition has investigated work settings such as ship navigation (Hutchins, 1995) and flight deck operations on aircraft carriers (Weick and Roberts, 1993) where judgmental errors can have catastrophic effects. Findings show that, despite the low predictability of problem-solving routines and the mixing of formal and informal sources of information, reliable performance occurs.

Designing information technologies to support a process of learning that is distributed in this fashion is clearly a challenge. Hutchins (1995) provided insightful detail on the introduction of a simple manual calculator into the task of plotting a naval ship’s location entering a harbor. He argued that the calculator changed the relationship of the navigation team to its task, partly because it also introduced new opportunities for errors. The example illustrates how even simple technologies are prone to human errors and shows how distributed learning systems may spontaneously produce improvised work practices to compensate for limitations in formal role requirements and information sources. Hutchins showed that data become available primarily via social interactions, making the plotting of the ship’s course “largely an unplanned side effect of this interactional structure. The interactional structure itself is chaotic because it is shaped by interference from other tasks and by social interactions with other members of the navigation team and with members of other work teams on the bridge” (Hutchins, 1995: 327).

Future research on information technologies to support organizational learning can incorporate this concept of distributed memory and learning. Some prototype systems are designed around the assumption that cognition is distributed (e.g., Boland *et al.*, 1994), yet these studies have not investigated how such artifacts are used in combination with other sources of information, both technical and human. We might speculate that more reliable performance would be evident where a work group had greater freedom to mix technological options to match their own definition of task requirement. Thus, an effective support system for organizational learning might contain few tightly constrained features and offer greater flexibility and adaptability. Such speculations are consistent with case studies of how organizational memory information systems are actually used in organizations (e.g., Goodman and Darr, 1998) but they need to be confirmed with empirical research.

### **Demonstrating the Effectiveness of Organizational Memory Systems in Practice**

Most research on the design of information technologies to support organizational learning is restricted to proving design concepts analytically or building prototype systems, but the effectiveness of design concepts in practice is merely assumed or left for future research. Future research should document the business and economic value of organizational learning technologies in practice. As our review of the first stream of research shows, new technologies may not be received favorably or used as intended, making assumptions about their impacts on actual performance quite speculative. We propose that speculation be replaced by case studies and field experiments that provide a convincing link between the implementation of learning technologies, their effects on learning, and their consequences for organizational performance. Without such links, research on information technology and organizational learning will continue



to attract research attention, but practitioners may become skeptical of claims regarding its usefulness.

The research reported by El Sawy and Bowles (1997), discussed earlier, demonstrates how such research can be successfully pursued. Their article provided a useful list of dependent variables for measuring the effectiveness of organizational memory information systems in practice. By studying the effects of these and other applications of information technology to support organizational learning in real organizations, researchers can progress beyond solving “toy problems” and demonstrating concept proofs. As research in this area continues, we may eventually compile an inventory of organizational learning technologies that could be applied to particular groups of problems, such as customer support, environmental scanning, or group learning. Essentially, such an inventory may provide benchmark data for evaluating the potential success of a given application. El Sawy and Bowles’ (1997) approach to this type of research can guide comparable efforts on other problems and systems.

### **Drawing from Research in Related Fields**

Finally, researchers designing systems to support organizational learning are advised to learn from related research areas, such as software reuse. One of the central principles in object-oriented system development is the establishment of libraries of reusable software components that can be reassembled to make new systems. These libraries are, quite literally, repositories of organizational memory, and a sizable body of research literature on software reuse has appeared independently of research on organizational learning (e.g., Yglesias, 1993). Such studies and others may be used either as analogues or as direct evidence of the usefulness of organizational memory. As with organizational memory information systems, organizational practices

involving methodologies for software reuse vary widely (Banker, Kauffman and Zweig, 1993). Researchers interested in designing technology support for organizational learning should consult the research literatures in such related areas to avoid reinventing the wheel. Clearly, it would be ironic for organizational learning researchers to neglect established repositories of research results.

These future directions are offered early in the history of research on organizational learning and information technology. Unlike a comprehensive literature review that seeks to assess what we have learned from many years of research, this review takes a more proactive stance by organizing the nascent tributaries of research into identifiable streams and by offering specific directions for their future courses. There is little question about the importance of organizational learning or the potential of information technology to support it. However, academic researchers desiring to contribute to our general knowledge need to be aware of what has been accomplished and what remains to be established. By making our review and assessment comprehensive, crossing two distinct research paradigms, we hope to contribute to the need for dialogue between the paradigms and the increased knowledge that may result.

## References

- Anand, Vikas, Charles C. Manz and William H. Glick, "An Organizational Memory Approach to Information Management," *Academy of Management Review*, 23, 4 (1998), 796-809.
- Ang, Kwang-Tat, James Y.L. Thong and Chee-Sing Yap, "IT Implementation Through the Lens of Organizational Learning: A Case Study of INSUROR," in K. Kumar and J.I. DeGross (Eds), *Proceedings of the 18th International Conference on Information Systems*, (1997), 331-348.
- Argote, Linda, Sara L. Beckman and Dennis Epple, "The Persistence and Transfer of Learning in Industrial Settings," *Management Science*, 36, 2 (1990), 140-154.
- Argyris, Chris, "Organizational Learning and Management Information Systems," *Accounting, Organizations and Society*, 2, 2 (1977), 113-123.
- Argyris, Chris, "Unrecognized Defenses of Scholars: Impact on Theory and Research," *Organization Science*, 7, 1 (1996), 79-87.
- Argyris, Chris and Donald A. Schön, *Organizational Learning*, Addison-Wesley, Reading, Mass., 1978.
- Argyris, Chris and Donald A. Schön, *Organizational Learning II*, Addison-Wesley, Reading, Mass., 1996.
- Attewell, Paul, "Technology Diffusion and Organizational Learning: The Case of Business Computing," *Organization Science*, 3, 1 (1992), 1-19.
- Banker, Rajiv D., Robert J. Kauffman and Dani Zweig, "Repository Evaluation of Software Reuse," *IEEE Transactions on Software Engineering*, 19 (1993), 379-389.
- Baskerville, Richard L. and Jan Stage, "Controlling Prototype Development Through Risk Analysis," *MIS Quarterly*, 20, 4 (1996), 481-504.
- Boland Jr., Richard J., Ramkrishnan V. Tenkasi and Dov Te'eni, "Designing Information Technology to Support Distributed Cognition," *Organization Science*, 5, 3 (1994), 456-475.
- Bostrom, Robert P., "Successful Application of Communication Techniques to Improve the Systems Development Process," *Information & Management*, 16, (1989), 279-295.
- Bowker, Geoffrey C., "Lest We Remember: Organizational Forgetting and the Production of Knowledge," *Accounting, Management and Information Technologies*, 7, 3 (1997), 113-138.
- Brown, John Seely, "Internet Technology in Support of the Concept of 'Communities-of-Practice': The Case of Xerox," *Accounting, Management and Information Technologies*, 8, (1998), 227-236.

- Caron, Raymond J., Sirkka L. Jarvenpaa and Donna B. Stoddard, "Business Reengineering at CIGNA Corporation: Experiences and Lessons Learned From the First Five Years," *MIS Quarterly*, 18, 3 (1994), 233-250.
- Cohen, H.B., "The Performance Paradox," *Academy of Management Executive* 12, 3 (1998), 30-40.
- Cohen, Michael D., "Individual Learning and Organizational Routine: Emerging Connections," *Organization Science*, 2, 1 (1991), 135-139.
- Crossan, Mary and John Hulland, "Measuring Organizational Learning," paper presented to the Academy of Management, 1997.
- Crossan, Mary, Henry W. Lane and Roderick E. White, "An Organizational Learning Framework: From Intuition to Institution," *Academy of Management Review*, 24, 3 (1999), 522-537.
- Davenport, Thomas H., David W. De Long and Michael C. Beers, "Successful Knowledge Management Projects," *Sloan Management Review*, 39, 2 (1998), 43-57.
- Dodgson, Mark, "Organizational Learning: A Review of Some Literatures," *Organization Studies*, 14, 3 (1993), 375-394.
- Duncan, Robert and Andrew Weiss, "Organizational Learning: Implications for Organizational Design," *Research in Organizational Behavior*, 1 (1979), 75-123.
- El Sawy, Omar A. and Gene Bowles, "Redesigning the Customer Support Process for the Electronic Economy: Insights From Storage Dimensions," *MIS Quarterly*, 21, 4 (1997), 457-483.
- Elofson, Gregg S. and Benn R. Konsynski, "Performing Organizational Learning with Machine Apprentices," *Decision Support Systems*, 10, 2 (1993), 109-119.
- Epple, Dennis, Linda Argote and Rukmini Devadas, "Organizational Learning Curves: A Method for Investigating Intra-Plant Transfer of Knowledge Acquired through Learning by Doing," *Organization Science*, 2, 1 (1991), 58-70.
- Epple, Dennis, Linda Argote and Kenneth Murphy, "An Empirical Investigation of the Micro Structure of Knowledge Acquisition and Transfer Through Learning by Doing," *Operations Research*, 44, 1 (1996), 77-86.
- Fichman, Robert G. and Chris F. Kemerer, "The Assimilation of Software Process Innovations: An Organizational Learning Perspective," *Management Science*, 43, 10 (1997), 1345-1362.
- Fiol, C. Marlene, "Consensus, Diversity, and Learning in Organizations," *Organization Science*, 5, 3 (1994), 403-420.

- Fiol, C. Marlene and Marjorie A. Lyles, "Organizational Learning," *Academy of Management Review*, 10, 4 (1985), 803-813.
- Fleck, James, "Learning by Trying: The Implementation of Configurational Technology," *Research Policy*, 23, 6 (1994), 637-652.
- Gaimon, Cheryl, "Planning Information Technology-Knowledge Worker Systems," *Management Science*, 43, 9 (1997), 1308-1328.
- George, Joey F., Suzanne Iacono and Rob Kling, "Learning in Context: Extensively Computerized Work Groups as Communities-Of-Practice," *Accounting, Management and Information Technologies*, 5, 3/4 (1995), 185-202.
- Gill, T. Grandon, "High-Tech Hidebound: Case Studies of Information Technologies that Inhibited Organizational Learning," *Accounting, Management and Information Technologies*, 5, 1 (1995), 41-60.
- Goodman, Paul S. and Eric D. Darr, "Computer-Aided Systems and Communities: Mechanisms for Organizational Learning In Distributed Environments," *MIS Quarterly*, 22, 4 (1998), 417-440.
- Hammer, Michael, "Re-engineering Work: Don't Automate, Obliterate," *Harvard Business Review*, 68, 4 (1990), 104-112.
- Hammer, Michael, *Beyond Reengineering*, Harper Business, New York, 1996.
- Hedberg, Bo, "How Organizations Learn and Unlearn," In P.C. Nystrom and W.H. Starbuck (Eds.), *Handbook of Organizational Design*, Oxford University Press, New York, 1981, 3-27.
- Hine, Michael J. and Michael Goul, "The Design, Development, and Validation of a Knowledge-Based Organizational Learning System," *Journal of Management Information Systems*, 15, 2 (1998), 119-152.
- Huber, George P., "Organizational Learning: The Contributing Processes and the Literatures," *Organization Science*, 2, (1991), 88-115.
- Hutchins, Edwin, *Cognition in the Wild*, MIT Press, Cambridge, MA, 1995.
- Jones, Matthew R., "Organisational Learning: Collective Mind or Cognitivist Metaphor?" *Accounting, Management and Information Technologies*, 5, 1 (1995), 61-77.
- Kaiser, Kate M. and Robert P. Bostrom, "Personality Characteristics of MIS Project Teams: An Empirical Study and Action-Research Design," *MIS Quarterly*, 6, 4 (1982), 43-60.
- Käkölä, Timo K., "Designing and Deploying Coordination Technologies for Fostering Organizational Working and Learning: From Vision to Reality?" *Scandinavian Journal of Information Systems*, 7, 2 (1995a), 45-74.

- Käkölä, Timo K., "Increasing the Interpretive Flexibility of Information Systems Through Embedded Application Systems," *Accounting, Management and Information Technologies*, 5, 1 (1995b), 79-102.
- Käkölä, Timo K. and Kalle I. Koota, "Dual Information Systems: Supporting Organizational Working and Learning by Making Organizational Memory Transparent," *Journal of Organizational Computing and Electronic Commerce*, 9, 2 (1999a), 205-232.
- Käkölä, Timo K. and Kalle I. Koota, "Redesigning Computer-Supported Work Processes with Dual Information Systems: The Work Process Benchmarking Service," *Journal of Management Information Systems*, 16, 1 (1999b), 87-119.
- Karsten, Helena, "'It's Like Everyone Working Around the Same Desk'; Organisational Readings of Lotus Notes," *Scandinavian Journal of Information Systems*, 7, 1 (1995), 3-32.
- Karsten, Helena, "Relationship Between Organizational Form and Organizational Memory: An Investigation in a Professional Service Organization," *Journal of Organizational Computing and Electronic Commerce*, 9, 2 (1999), 129-150.
- Klein, Jonathan I., "Parenthetic Learning in Organizations: Toward the Unlearning of the Unlearning Model," *Journal of Management Studies*, 26, 3 (1989), 291-308.
- Lave, Jean and Etienne Wenger, *Situated Learning: Legitimate Peripheral Participation*, Cambridge University Press, Cambridge, UK, 1991.
- Levitt, Barbara and James G. March, "Organizational Learning," *Annual Review of Sociology*, (1988), 319-340.
- Lim, Kai H., Lawrence M. Ward and Izak Benbasat, "An Empirical Study of Computer System Learning: Comparison of Co-Discovery and Self-Discovery Methods," *Information Systems Research*, 8, 3 (1997), 254-272.
- Lyytinen, Kalle and Daniel Robey, "Learning Failure in Information Systems Development," *Information Systems Journal*, 9 (1999), 85-101.
- Mann, Leon, Danny Samson and Douglas Dow, "A Field Experiment on the Effects of Benchmarking and Goal Setting on Company Sales Performance," *Journal of Management*, 24, 1 (1998), 73-96.
- March, James G., "Exploration and Exploitation in Organizational Learning," *Organization Science*, 2, 1 (1991), 71-87.
- Martins, Luis L. and Ajit Kambil, "Looking Back and Thinking Ahead: Effects of Prior Success on Managers' Interpretations of New Information Technologies," *Academy of Management Journal*, 42, 6 (1999), forthcoming.
- Miller, Danny, "The Architecture of Simplicity," *Academy of Management Review*, 18, 1 (1993), 116-138.

- Miner, Anne S. and Stephen J. Mezias, "Ugly Duckling No More: Past and Futures of Organizational Learning Research," *Organization Science*, 7, 1 (1996), 88-99.
- Nonaka, I., "A Dynamic Theory of Organizational Knowledge Creation," *Organization Science*, 5, 1 (1994), 14-37.
- Orlikowski, Wanda J., "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science*, 3, 3 (1992), 398-427.
- Orlikowski, Wanda J., "Improvising Organizational Transformation Over Time: A Situated Change Perspective," *Information Systems Research*, 7, 1 (1996), 63-92.
- Orlikowski, Wanda J. and Debra C. Gash, "Technological Frames: Making Sense of Information Technology in Organizations," *ACM Transactions on Information Systems*, 12, 2 (1994), 174-207.
- Orr, Julian E., *Talking About Machines : An Ethnography of a Modern Job*, ILR Press, Ithaca, N.Y., 1996.
- Ouksel, Aris M., Ken Mihavics and Peter Chalos, "Accounting Information Systems and Organization Learning: A Simulation," *Accounting, Management and Information Technologies*, 7, 1 (1997), 1-19.
- Pentland, Brian T., "Information Systems and Organizational Learning: The Social Epistemology of Organizational Knowledge Systems," *Accounting, Management and Information Technologies*, 5, 1 (1995), 1-21.
- Raelin, J.A., "A Model of Work-Based Learning," *Organization Science*, 8, 6 (1997), 563-578.
- Ramesh, Balasubramaniam, "Towards a Meta-Model for Representing Organizational Memory," *Proceedings of the Thirtieth Hawaii International Conference on System Sciences*, 2 (1997), 320-329.
- Ramesh, Balasubramaniam and V. Dhar, "Supporting Systems Development by Capturing Deliberations during Requirement Engineering," *IEEE Transactions On Software Engineering*, 18 (1992), 498-510.
- Robey, Daniel and Marie-Claude Boudreau, "Accounting for the Contradictory Organizational Consequences of Information Technology: Theoretical Directions and Methodological Implications," *Information Systems Research*, 10, 2 (1999), 167-185.
- Robey, Daniel and Michael Newman, "Sequential Patterns in Information Systems Development: An Application of a Social Process Model," *ACM Transactions on Information Systems*, 14, 1 (1996), 30-63.
- Robey, Daniel, Nicole A. Wishart and Andres G. Rodriguez-Diaz, "Merging the Metaphors for Organizational Improvement: Business Process Re-engineering as a Component of

- Organizational Learning," *Accounting, Management and Information Technologies*, 5, 1 (1995), 23-39.
- Robey, Daniel, Huoy Min Khoo and Carolyn Powers, "Situated Learning in Cross-Functional Virtual Teams," *IEEE Transactions on Professional Communication*, forthcoming.
- Romm, Celia T., Nava Pliskin and William D. Rifkin, "Diffusion of E-mail: An Organizational Learning Perspective," *Information & Management*, 31, 1 (1996), 37-46.
- Sahay, Sundeep and Daniel Robey, "Organizational Context, Social Interpretation, and the Implementation and Consequences of Geographic Information Systems," *Accounting, Management and Information Technologies*, 6, 4 (1996), 255-282.
- Salaway, Gail, "An Organizational Learning Approach to Information Systems Development," *MIS Quarterly*, 11, 2 (1987), 245-264.
- Saraswat, Satya Prakash and John T. Gorgone, "Organizational Learning Curve in Software Installation: An Empirical Investigation," *Information & Management*, 19, 1 (1990), 53-59.
- Senge, Peter, *The Fifth Discipline: The Art and Practice of the Learning Organization*, Doubleday, New York, 1990.
- Stähler, Samuel G. and Jörn W. Ewaldt, "Simulation Modeling and Analysis of Complex Learning Processes in Organization," *Accounting, Management and Information Technologies*, 8, 4 (1998), 255-263.
- Stein, Eric W. and Vladimir Zwass, "Actualizing Organizational Memory with Information Systems," *Information Systems Research*, 6, 2 (1995), 85-117.
- Tyre, Marcie J. and Wanda J. Orlikowski, "Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations," *Organization Science*, 5, 1 (1994), 98-118.
- Tyre, Marcie J. and Eric von Hippel, "The Situated Nature of Adaptive Learning in Organizations," *Organization Science*, 8, 1 (1997), 71-81.
- Van De Ven, Andrew H. and Douglas Polley, "Learning While Innovating," *Organization Science*, 3, 1 (1992), 92-116.
- Vandenbosch, Betty and Michael J. Ginzberg, "Lotus Notes and Collaboration: Plus ça change..." *Journal of Management Information Systems*, 13, 3 (1996-97), 65-81.
- Walsh, James P. and Gerardo Rivera Ungson, "Organizational Memory," *Academy of Management Review*, 16, 1 (1991), 57-91.
- Wang, Shouhong, "Organizational Memory Information Systems: A Domain Analysis in the Object-Oriented Paradigm," *Information Resources Management Journal*, 12, 2 (1999), 26-34.



- Wegner, D.M., "Transactive Memory: A Contemporary Analysis of the Group Mind," In B. Mullen and G.R. Goethals (Eds.), *Theories of Group Behavior*, Springer-Verlag, New York, 1986, 185-208.
- Weick, Karl E. and Karlene H. Roberts, "Collective Mind in Organizations: Heedful Interrelating on Flight Decks," *Administrative Science Quarterly*, 38, 3 (1993), 357-381.
- Wijnhoven, Fons, "Development Scenarios for Organizational Memory Information Systems," *Journal of Management Information Systems*, 16, 1 (1999), 121-146.
- Wishart, Nicole A., Joyce J. Elam and Daniel Robey, "Redrawing the Portrait of a Learning Organization: Inside Knight-Ridder, Inc.," *The Academy of Management Executive*, 10, 1 (1996), 7-20.
- Yap, Alexander Y. and Niels Bjørn-Andersen, "Energizing the Nexus of Corporate Knowledge: A Portal Toward the Virtual Organization," In R. Hirschheim, M. Newman and J.I. DeGross (Eds.), *Proceedings of the 19th International Conference on Information Systems*, 1998, 273-286.
- Yetton, Philip W., Kim D. Johnston and Jane F. Craig, "Computer-Aided Architects: A Case Study of IT and Strategic Change," *Sloan Management Review*, Summer (1994), 57-67.
- Yglesias, K. P., "Information Reuse Parallels Software Reuse," *IBM Systems Journal*, 32, 4 (1993), 615-620.
- Zhu, Dan, Michael J. Prietula and Wen Ling Hsu, "When Processes Learn: Steps Toward Crafting an Intelligent Organization," *Information Systems Research*, 8, 3 (1997), 302-317.

Figure 1. Classification Diagram of the Empirical Literature

**ORGANIZATIONAL LEARNING ABOUT INFORMATION TECHNOLOGY**

- **The Role of Experience**
- **Overcoming Knowledge Barriers**
  - || *Formal training.*
  - || *Action research.*
  - || *Social context of learning.*
  - || *Learning from others.*
- **Dynamics of Learning**

**INFORMATION TECHNOLOGY DESIGNED TO SUPPORT ORGANIZATIONAL LEARNING**

- **Information Technology as an Enabler of Organizational Learning**
  - || *Systems designed to enhance organizational memory.*
    - ||| *Conceptual design.*
    - ||| *Knowledge representation.*
    - ||| *Retrieval and use.*
  - || *Systems to support communication and discourse.*
- **Information Technology as a Disabler of Organizational Learning**

Figure 2. Relationship Between the Two Research Streams

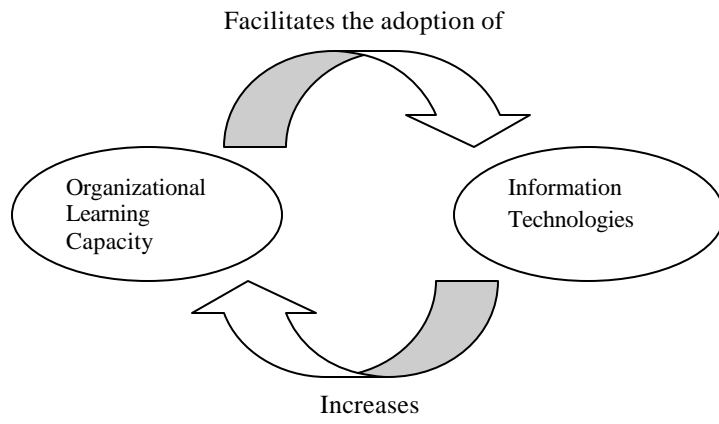
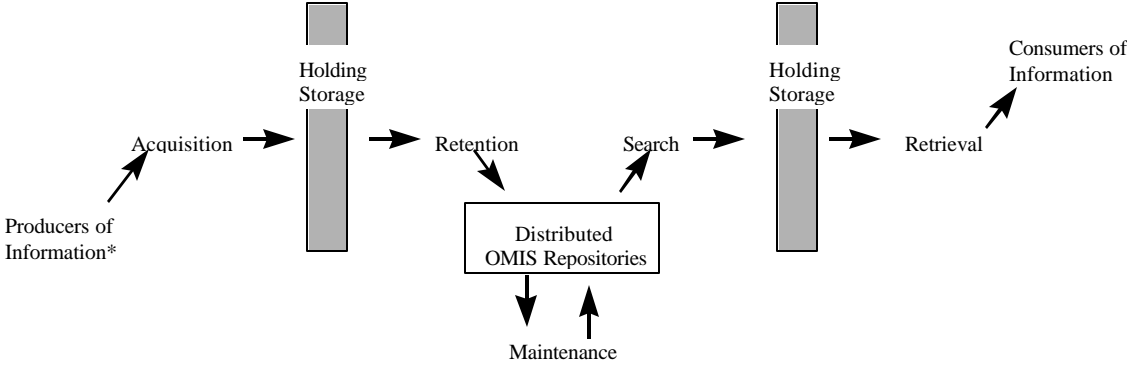


Figure 3. Mnemonic Functions of an OMIS (Source : Stein and Zwass, 1995, p.103)



\*Internal and external, as well as organizational and individual producers of information