Computer-Aided Systems and Communities: Mechanisms for Organizational Learning in Distributed Environments[1]

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Abstract

This paper examines the role of computer-aided systems (CAS) for enhancing organizational learning in distributed environments. The basic research questions are: how do features of CAS enhance organizational learning, and how does organizational context influence the role of CAS in organizational learning?

The theoretical framework focuses on the decision to contribute and adopt knowledge in distributed environments. Specifically, the paper investigates the intersections between the features of CAS and inhibitors to contributing or adopting knowledge, in the light of different organizational context variables.

Two cases of information environments for knowledge sharing are examined: a formal electronic library system and an informal community that uses a variety of communication technologies. The cases are used to illustrate how the intersection between CAS features and the decisions to adopt and contribute enhance or inhibit knowledge sharing.

Keywords: CBCS, knowledge sharing, organizational learning, field study

ISRL Categories: AI0108, DD06, HA08

Introduction

This paper focuses on the role of computer-aided systems (CAS) for enhancing organizational learning in distributed environments. The basic research questions are: how do features of CAS enhance organizational learning, and how does organizational context influence the role of CAS in organizational learning? Two cases representing formal and informal CAS are examined.

Consider a company with multiple units, geographically distributed, performing similar functions (e.g., sales and service). It is likely these units are confronted with some similar problems, and some of the units have found solutions to these problems. The focus of this paper is on (1) how features of the computer-aided systems aid in matching problems and solutions and (2) how the organizational context defined in terms of characteristics of the problems and solutions (e.g., complexity),

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culture, and reward system affects the use of CAS for organizational learning.

Rationale

There are several reasons for examining the phenomena of CAS.

First, there is growing evidence that computer-aided systems are changing many organizational *processes* including communication (Kiesler and Sproull 1987), group decision making (Kiesler et al. 1984), coordination (Rice and Shook 1990), and collaborative work (Kraut et al. 1992). However, there are relatively few field studies dealing with computer-aided systems for facilitating organizational learning within an organization (Constant et al. 1996; Orlikowski 1993; Sproull and Kiesler 1986). To evaluate the generalizability of prior studies and to extend knowledge, an examination of forms of computer-based systems for organizational learning in different types of organizations is needed. For example, an examination of organizational learning in a firm where computers are the core technology was conducted earlier (Constant et al. 1996). This paper examines computer-aided systems in an organization where computers are *not* the core technology.

Second, there are some features of geographically distributed settings that make them quite interesting to study. On one hand, geographically distributed units of the same company are likely to have similar problems and solutions. Exchanging solutions is likely to benefit an individual unit as well as the larger organization. On the other hand, these units may have no task interdependencies and no interpersonal ties. Their focus of attention is likely to be on local unit activities, not on helping or sharing with others. Understanding forces for and against exchanges in such settings should sharpen the understanding of organizational learning processes.

Organizational learning has become a central theme for organizational and management theorists and practitioners (Argyris and Schon 1978; Levitt and March 1988; Nadler et al. 1992; Senge 1990). Indeed, improvement of learning processes is viewed as one of the major determinants of organizational effectiveness (Adler 1990; Stata 1989). The contribution of this paper to the literature is to examine the role of information technology in facilitating this process (Goodman and Darr 1996).

Finally, the problem focus of this paper has obvious implications for practice. Creating effective learning processes (Stata 1989) represents one strategy for firms to gain a sustainable competitive advantage. Matching problems and solutions across geographically distributed units in the same company should improve the effectiveness of the units and the organization. However, there are counter forces to these exchanges. Managers need to understand both the role of information technology and the organizational inhibitors and facilitators for exchanging knowledge across these distributed units.

Theory

Computer-aided systems

Computer-aided systems, which are collections of technology, people, and organizational arrangements, have some unique features for facilitating organizational learning. First, they can provide fast and efficient communication, bridging space and time. Second, many systems have the capability of creating an organizational memory for all members. Third, CAS can provide a mechanism where multiple members can dynamically share and update their solutions to problems.

A study by Constant et al. (1996) provides a detailed view of a CAS for learning at Tandem Computer. The company has three classes of e-mail. The second class is used worldwide by employees to request information. Any employee can broadcast to all other employees requests for help (i.e., a problem). The other employees can respond to the request with possible solutions that are stored in a

public file, which is centrally managed. In addition, subsequent solutions or modifications can be added to the file. Another study reports on the implementation of a groupware product, Lotus Notes, in a large consulting firm (Orlikowski 1993). In this global organization, there is a lot of decentralized information on clients, consultants' expertise, markets, and industries. The role of the computer-based system was to identify expertise and information from the firm's global operation and share that information across distributed work settings. Lotus Notes automatically replicates individual contributions to all other users. The replication feature of Lotus Notes not only distributes knowledge, but it updates knowledge: Users automatically have access to the latest knowledge.

Computer-aided systems for organizational learning share some features with traditional e-mail systems such as the capability of bridging space and time. However, they differ from e-mail systems in the following respects: There is a memory device with indexing systems and search aids accessible and known to all members. There is a mechanism where all organizational members can dynamically share and update solutions. These systems also differ from "news groups" or "bulletin boards" because the process for selecting items for the organizational memory, updating these items, or broadcasting the availability of these items is more *formalized, structured,* and may use various forms of intelligent aids (Ackerman and McDonald 1996).

There are many other types of technologies to facilitate collaborative work in multi-user settings such as video conferencing, group decision support systems, and project management applications (Grudin 1988; Okamura et al. 1994). The focus here, however, is on CASs that facilitate the exchange and storage of problems and solutions.

Defining organizational learning

There are many definitions of organizational learning. For example, organizational learning is a process of detecting and correcting errors (Argyris 1993). Similarly, there is the suggestion that organizational learning is the process of improving actions through better knowledge and understanding (Fiol and Lyles 1985). Another argument is that an organization learns through its processing of information where the range of its potential behaviors is changed (Huber 1991). Behavior has also been explicity identified as an important component of organizational learning (Levitt and March 1988), with the suggestion that an organization learns by encoding inferences from history into routines that guide behavior.

Organizational learning is conceptualized here as the process by which one unit acquires knowledge from another unit in the same organization. Individual level learning occurs when solutions from one unit are matched to problems of an individual from another unit (problem-solution exchange). Organizational-level learning occurs when (1) the problem-solution exchanges and consequences are communicated and known by other organizational members *(broadcasting),* (2) there is some form of organizational memory (Walsh and Ungson 1991) that stores problem-solution exchanges and consequences *(memory),* and (3) there is a mechanism for organizations to share their interpretations (Brown and Duguid 1991) about the problem-solution exchanges and to update the organizational memory about their experiences *(updating).*

The following example may sharpen this definition of organizational learning. A service manager in Chicago discovers an important problem with a certain class of the company's machines and seeks help from the company's service manager in New York. Assume that the New York manager contributes a solution, which is adopted and successfully implemented in Chicago. At this point, the exchange of problems and solutions is at the *individual* level. To create *organizational* level learning, the results of this problem-solution exchange need to be broadcast to other organizational members and stored in some form of organizational memory so that the new learning is not contingent on the two service managers (e.g., whether they stay in the organization). Also, as

this solution is implemented in other places, there are likely to be new observations about how to solve this technical problem that can be shared with others through updating existing memory.

This example also raises some questions. First, how many other people need to learn about the problem-solution exchange for organizational learning to occur? If the Chicago service manager broadcasts his findings, either to all of his service employees or to his service employees and to managers in other offices, has more organizational learning occurred in the later scenario? It seems likely that as more people have knowledge and accessibility to an organizational memory, organizational learning increases. Also, as more people can potentially update an organizational memory, there is even greater potential for organizational learning

Research Framework

Figure 1 captures the basic elements in the framework. For organizational learning to occur, there must be both a decision to contribute and to adopt. To contribute means that individuals who have discovered solutions to problems are willing to share these with others in different locations. The sharing may be in response to a direct request or may be to provide the solution to some form of organizational memory. To adopt means that one has a problem and is willing to search for possible solutions in other locations. The search may be targeted directly to collections of employees, such as units or divisions, to specific individuals, or to some other form of organizational memory such as computer databases or library books.

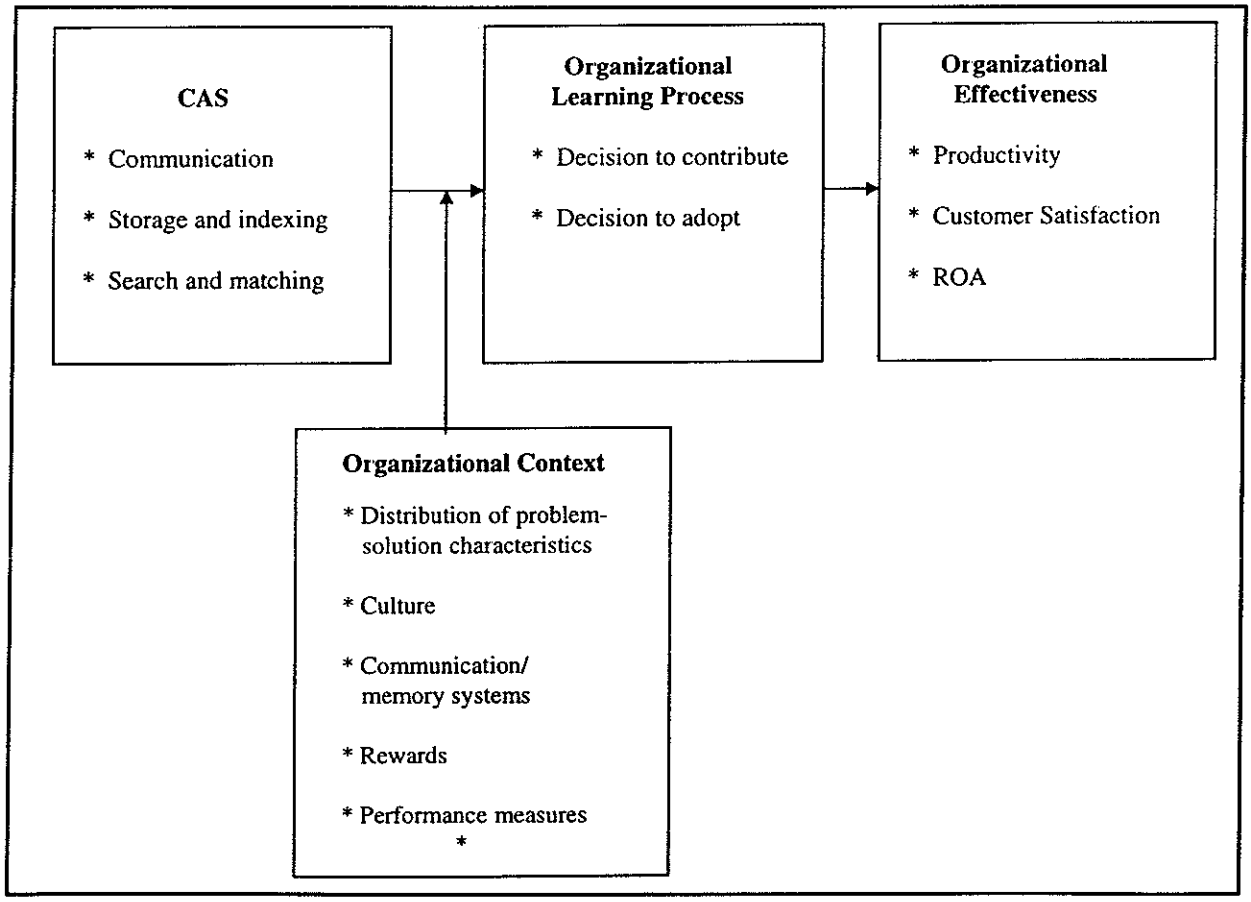

Figure 1. Basic Framework for Organizational Learning Using CAS

Computer-aided systems can play an important role in facilitating the decision to contribute and the decision to adopt. The manner in which a CAS facilitates broadcast, memory creation, search, and updating will influence the nature of the contribution and adoption decision processes. For example, sophisticated search mechanisms (Ackerman and McDonald 1996), such as semantic pattern recognition products produced by Verity and Excalibur, make location of relevant knowledge easy for users. Users of a CAS with these search capabilities may be more likely to engage in adoption than users who have no powerful search mechanisms and must rely on broadcasts to all employees to locate relevant knowledge.

The organizational context also plays a major role in affecting technology and learning processes (Goodhue and Thompson 1995; Markus 1994; Trist and Bamforth 1951; Tyre and Orlikowski 1994; Zuboff 1985). A culture of collaboration and sharing should facilitate the role of CAS and learning. However, rewards systems that focus on local units versus organizational interests should substantially reduce the propensity to exchange problems and solutions. Further, the nature of the task structure will influence the form of problems and solutions to be exchanged. In some cases, the problems and solutions will be relatively simple. Here, the demands on the communication, search, and storage mechanisms of a CAS may be very different from an environment where the problems and solutions are very complex and high in technical content. In addition, the organizational context provides alternative communication and memory mechanisms, which may either compete with or complement a CAS. The organization, for example, may require participants in distributed settings to meet periodically. How do these face-to-face communications complement or compete with exchanges via CAS?

The last component of this model is the dimension of organizational effectiveness. The improvement of learning processes should contribute to higher effectiveness which might be indicated by increases in levels of productivity and customer satisfaction.

The paper now progresses from the consideration of the general components in the framework to a more careful consideration of the components and the interaction of components.

Decision to Contribute

In the decision to contribute, one is confronted with two activities: formulating and delivering the solution. In the first activity, one must formulate what has been learned. What was the problem, what solution did I use, how did I implement it, and where will this solution work and not work? The delivery activity is presenting what has been learned in a way that is meaningful to others.

The basic thesis is that there are inherent costs in contributing. First, formulating and delivering solutions takes time and energy (Constant et al. 1996). Also, the contributor might reasonably expect that the act of providing help would evoke additional clarifications or more requests for assistance, which will ultimately increase costs. Second, why should someone contribute solutions to problems in a distributed organizational environment? Rewards in helping strangers are less likely to be as strong as when helping others who have similar or personal connections with the contributor (Krackhardt 1992). Also, exchanges with low probability of reciprocity may not be initiated or be considered helpful (Thorn and Connolly 1987). Third, learning how to contribute takes time and energy. This is particularly true for learning how to use a new CAS for contribution delivery. Also, keeping track of formatting and other delivery requirements takes time away from business activities.

There may be several positive motivators for contributing (Constant et al. 1996). Helping others may reinforce one's technical competency and, thus, feelings of self-esteem. However, the absence of feedback about whether the advice was adopted or successful, which is likely in geographically distributed exchanges, may mitigate the strength of this motivation. Another positive motivator may be a shared value of cooperation and citizenship.

If this value is shared and reinforced throughout the organization, contributing behavior is much more likely. However, it is difficult to create such a shared understanding in the current competitive organizational environment where downsizing, temporary workers, and changing psychological contracts are the norm (Rousseau and Parks 1993).

The picture being drawn of the contributor is a person who may provide solutions to problems independent of any request or in response to a request. In either case, contribution requires time and effort and likely results in little offsetting reciprocal rewards or benefits, particularly when there are no personal or direct work ties. The contributors' investments do not directly impact favorably on his or her own job or larger work unit.

The nature of what is to be exchanged—the problem-solution characteristics—will affect both the contribution and adoption decision.

Following previous research (Newell and Simon 1972, Simon and Lea 1974), problems and solutions are characterized in terms of (1) environmental conditions surrounding the problem statements, (2) the nature of the solution set, (3) the rules to implement the solutions, and (4) the nature of the results of the solution. The basic proposition is that variation of any of these four dimensions can make exchanges inherently more or less difficult.

Consider the following two examples. The service manager in Chicago has downtime problems with a particular machine. One system on that machine regularly breaks during high volume production runs. The New York service manager has had the same experience with that machine and has discovered that a simple part replacement solves the problem (i.e., no more downtime). In this case, matching and exchanges are straightforward. The Chicago service manager has another class of machines that randomly break down. Each breakdown seems to be related to a different subsystem malfunction. This manager has not found an acceptable solution. The New York service manager has the same problem with that class of machine. His service group has initiated a large number of solutions. In some cases, the rules used to implement the solutions work, and in other cases, downtime is not reduced. In this second case, there are a large number of subsystems that break down. There are different classes of solutions and implementation rules for each subsystem. Also, the causal structure underlying this problem is now well known. In the second example, the exchange will be more difficult.

How can problem-solution features influence the decision to contribute? The first argument is that problem complexity inhibits exchange (Daft and Lengel 1986; Perrow 1967). Multiple attributes are needed to describe a complex problem and the environmental conditions surrounding it. Also, for complex problems, there are many possible solutions and many rules to implement any particular solution. For the contributor, it will be much more difficult to formulate and deliver complex solutions. Problem-solution exchanges, on the other hand, should be relatively easy when the problem statement has few attributes and there is a single solution with few implementation rules.

The second argument concerning the difficulty in exchanging problems and solutions deals with the distinction between explicit and tacit knowledge (Polanyi 1966). This issue has been elaborated recently in a variety of perspectives on organizational learning (Nonaka 1994). In the present context, the application is relatively straightforward. Some problem statements and their environmental conditions may be difficult to articulate. Similarly, rules for implementing a solution may be understood, but it may be difficult to articulate why certain rules fit some solutions and not others. In both of these cases, the process of contribution among geographically distributed units will be difficult. The contributor cannot articulate the key elements of the exchange. Since the contributor and adopter are geographically separated, learning via observation or apprenticeship are less feasible options. In this situation, it will be difficult to create an organizational memory of shared interpretative schemes (Lave 1991).

Decision to Adopt

In this decision, one looks outside one's unit for solutions to problems. It is argued here that despite the obvious benefits of possibly finding a solution, there are inherent costs or inhibitors in adoption. First, searching for possible solutions outside one's local environment requires time and effort. Second, matching problems and solutions also may be costly. For example, the language used to describe problems or solutions in one part of the organization may differ from those in any other part. Translating between two or more local representations will likely take time and effort. Third, even if a problem-solution match were identified, the adopter must rely on people who are not well known and on information not easily verifiable. Finally, asking for help creates awareness in a broader and unknown audience that one has a problem. Reluctance to admit weakness can inhibit the motivation to adopt.

This analysis can be contrasted with a situation of searching for solutions in one's own work environment. Here, one is more likely to know the experts. Given the similar work context, it should be easier to match solutions and problems. One is more likely to search among friends or known colleagues, so quality of information received is likely to be easier to assess.

The prior discussion on problem-solution characteristics holds for the adoption decision. The initial assumption in this paper is that there are inherent costs in searching and matching solutions to problems. As the complexity of the problem-solution characteristics increase, so do the costs of adoption. Similarly, the greater the tacit component in the problem-solution characteristics, the higher the adoption costs.

This section concludes by noting our first two theoretical assumptions:

- Costs are inherent in the contribution and adoption decisions. These costs reduce the likelihood of adopting or contributing.

- Problem-solution characteristics (i.e., the complexity and level of tacit knowledge) affect these inherent costs. Greater levels of complexity or tacit knowledge reduces the likelihood of adopting or contributing.

CAS and the decision to contribute and adopt

The features of a CAS can increase or decrease the costs associated with the decision to contribute or adopt (Figure 2). This proposition is examined in terms of the communications or broadcast, memory creation, search, matching, and updating capabilities that are part of a CAS for organizational learning. In addition, it is noted that the access or availability of a CAS will impact its usefulness, independent of its capabilities. In some organizations these systems are not available to all members. For example, some organizational members may work in the field (e.g., sales) and not have access to the company's computer system. This obviously constrains any exchanges of problems and solutions via a CAS.

The communication capabilities of a CAS can be described in terms of (1) the primary form of media supported by the CAS, such as text, audio, video, and animation, (2) whether it provides synchronous and/or asynchronous communications, (3) bandwidth of the channels, and (4) the anonymity of both the adopter and the contributor.

These communication capabilities will impact on organizational members' abilities to search for potential solutions and match problems and solutions, keys to organizational learning. In the case of complicated problems and solutions, the richness of the communication system will play a critical role (Daft and Lengel 1986). To the extent that a CAS supports problem and solution representations using multiple media, matching problem and solutions should be easier.

The creation of an organizational memory is a second capability of a CAS. A key ingredient in organizational (versus individual) learning is that problems and solutions are stored in some organizational memory (Walsh 1995) and are

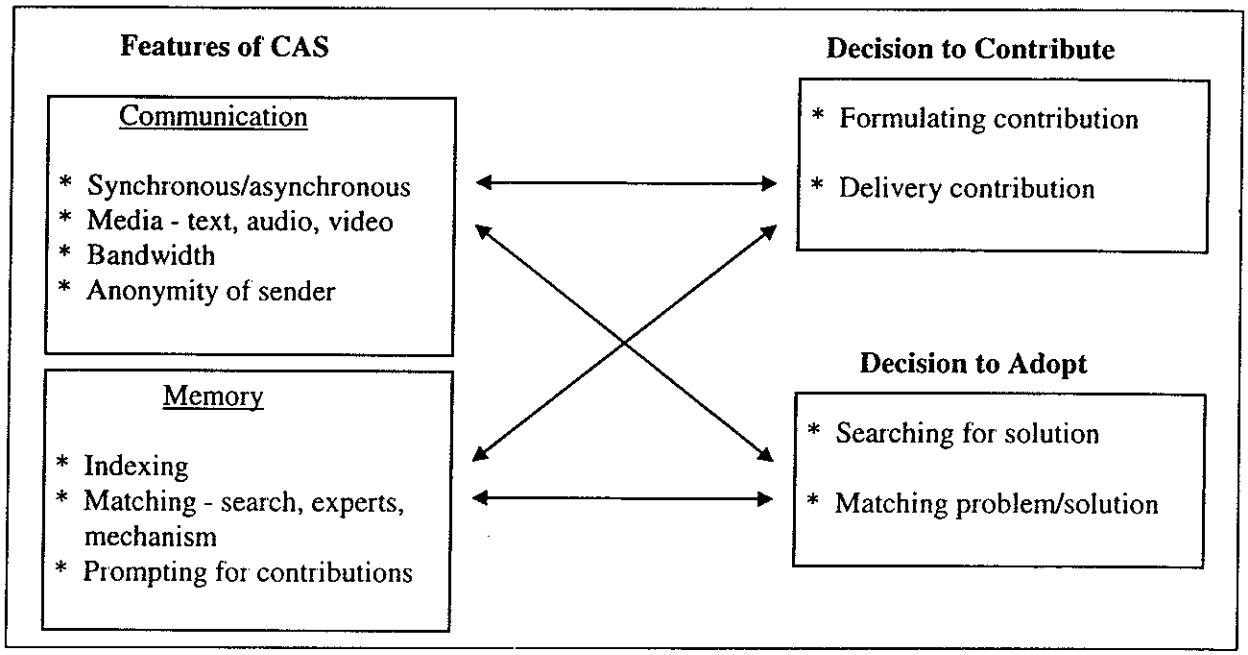

Figure 2. Features of CAS and Decisions to Contribute and Adopt

accessible by others. The ease of storage and subsequent accessibility by potential adopters is driven by the nature of the content taxonomy and the associated indexing system. Problem and solution categorization schemes (i.e., taxonomies) that are sufficiently detailed and that capture intercategory relationships should reduce search costs. In the current study, one CAS had a very simple indexing system with very general categories (e.g., customer satisfaction). This indexing system was not user-friendly and the taxonomy was too general to be useful. The memory creation capability of this specific CAS generated a lot of work for the users trying to store solutions or match problems with solutions.

Searching and matching are interrelated CAS capabilities. These capabilities may be characterized in terms of whether there is some form of intelligent agent to help in searching for solutions and matching problems with solutions. One can think of a continuum that ranges from no agent, to the ability to perform key word searches, to the use of powerful search technologies such as semantic network and adaptive pattern recognition processing (APRP). A semantic network contains not only the keyword definitions, but also the relationships between the key words. Users of a CAS with semantic network-enabled search capabilities can specify problem context much more accurately than users without this capability. The ability to accurately and completely specify problem context should ease matching. Similarly, APRP technology recognizes patterns in digital code and allows users to perform "fuzzy searches." A CAS with APRP technology can help users match problems with solutions that might be stored in forms other than text, such as images or videos.

Search and matching capabilities may also be characterized by the extent to which a CAS aids identification of experts and supports interactive help systems (Ackerman and McDonald 1996). In some exchanges of problems and solutions where the level of complexity and tacit knowledge is high, the need for human expertise in the matching process will become more apparent.

Another CAS capability concerns mechanisms for updating. The definition of organizational learning in this paper focuses both on problem-solution match and updating organizational

memory about the consequences of this exchange. This means accessing the insights and experiences, organizing the information, and storing it in an appropriate place is an important part of the organizational learning process. (See Ackerman and McDonald's 1996 discussion of collaborative refining.)

How can a CAS reduce contribution costs? Consider again the Chicago service manager whose unit has discovered new solutions to downtime of a particular machine. One function of search and matching processes could be to help the Chicago manager to formulate the solution. That is, there could be an interactive system that prompts for comprehensive information and organizes this information. As the complexity of the problem-solution increases, so would the need for an intelligent prompting system. The alternative is that there is no mechanism to help in formulation or indicating where to put the information. The second task associated with contribution is to deliver the solution. The ease of delivery (voice versus text), the capabilities of the delivery system (text, video, audio), and the opportunity to seek clarification both synchronously and asynchronously would reduce the cost of delivery, particularly with a complex problem-solution exchange.

Features of the CAS also can impact on the decision to adopt. Scenarios of a service manager in San Francisco searching for help on a machine that recently has had many reported down times by customers illustrates these ideas. In the first scenario, the service manager has access to a CAS and does a preliminary search in a database in which solutions and expertise are categorized by machine. In scanning for information under the specific machine category, the manager finds no relevant information. The next scenario is to identify the expert for this machine and query that person. The nature of the communication systems (synchronous versus asynchronous, the form of media, and the bandwidth of the channels) and the nature of the problem will affect whether this search avenue generates the appropriate information. Assume the problem is complex and the e-mail only communication system with the expert does not yield any additional searches or information. The nature of other search engines in the CAS will influence the success of this next scenario. One can envision a CAS with intelligent agents who contact chat groups, use bulletin boards, or identify other agents in search of information for the San Francisco manager. Assume this leads to a successful problem-solution match.

Once the solution has been identified and implemented, the learning experiences need to be updated in memory. This brings us back to the contribution decision where prompts are needed to elicit, categorize, and store the new insights. This leads to the third theoretical assumption:

- Features of the CAS can reduce the costs of contributing or the costs of adopting. The capabilities of the CAS should match the problem-solution complexity and tacitness.

Organizational context and the decisions to contribute and adopt

Organizational context serves as a moderator in this study. The importance of examining both organizational and technological factors is well documented in the literature (Orlikowski 1993; Trist and Bamforth 1951; Walton 1989;). In this framework, context variables can be viewed as increasing or decreasing the costs inherent in the decision to contribute or to adopt. This analysis begins with a consideration of problem-solution characteristics and then turns to key organizational systems such as the reward and communication systems

In the analysis of the decisions to contribute and to produce, the distribution of problem and solution characteristics have been identified as an important moderator of knowledge exchanges. An organization's problem and solution characteristics will be a function of its core technologies. For example, if the core technology is low in task variety and high in task analyzability (Perrow 1967), the distribution of problem-solution features may be low in complexity and in tacit knowledge, therefore

reducing some of the costs of adoptions and contributions.

Perceived adoption and contribution costs will be affected by organizational factors such as culture and reward system. For example, if the organizational culture or reward system creates high levels of competition between the units, there will be less motivation to exchange problems and solutions and help the other unit. Alternatively, if there are rewards or recognition for sharing across units, greater sharing activities would be expected.

Another contextual variable is the existing communication and memory systems that exist independent of the CAS. Any organization will have a variety of formal and informal communication systems that may affect the exchange of problems and solutions. For example, the San Francisco manager may first telephone (formal communication mechanism) a friend whom he met socially in the company and who has expertise in the particular machine in question. In this case, the San Francisco manager uses a source that has been helpful in the past and does not access the CAS system. In another scenario, the manager contacts his friend to determine how one should search on the CAS. In both cases, the San Francisco manager finds a solution. In the first case, the existing communication system was competing with the CAS, while in the second case, it was complementary. Acknowledging the role of these alternative systems is important in understanding how CAS do or do not enhance organizational learning.

The last theoretical assumption is:

- Organizational context can moderate the impact of CAS on organizational learning. For example, if the features of the CAS reduce the costs of contributing and adopting, organizational learning should increase. However, if the organizational reward system does not encourage sharing behavior, the impact of this CAS on learning will be reduced.

Exploring the framework —two cases

Two cases about computer-aided systems for learning are now examined. In the first case, a team of managers and technicians developed and implemented a formal CAS to enhance organizational learning across 60 offices of a Fortune 100 company. In the course of studying this CAS, several informal geographically distributed communities, which had been established to share problems and solutions through a variety of formal computer-based systems, formal communication systems, and informal systems were observed. Both cases are used to highlight components in the framework and to extend the conceptualization of how CAS affects organizational learning.

Specifically, by using these cases with the four theoretical assumptions presented above, the empirical work can be organized around the following questions:

- How does the formal CAS (or distributed communities) reduce the costs inherent in the decisions to contribute and to adopt and enhance the incentives for these decisions?

- How does the problem/solution environment moderate the relationship between the formal CAS (or the distributed communities) and the two decisions?

- How do other organizational context variables moderate the relationship between the formal CAS (or the distributed communities) and the two decisions?

Methodology

Sample

The data for this study were collected from a division of a Fortune 100 company that sells and services equipment for business offices. The division is divided into roughly 60 sites involved in sales, service, and repair of office equipment, located throughout the United

States. Each site is organized the same way in terms of jobs and levels. Additionally, the reward structure is identical in each site. The natural control of these contextual factors allowed better tracing of the impacts of computer-aided systems and distributed communities.

Data collection methods

Semi-structured interviews were used to collect data in three representative sites. A sample of 25 participants was drawn from each site, reflecting differences in functional area (service versus sales) and hierarchical level (general manager versus technician). Participation was 100% in these on-site interviews. Since there were more people in service, people were selected to reflect these proportional differences. The total number of employees per site was approximately 200. Three interviewers collected the data. There were 30 hours of interview training spread over eight training sessions to ensure comparability among interviewers. Each interview, which was recorded by hand, lasted between 45 to 60 minutes. All interviewing per office was completed in a week. All field work was completed within a three month time period. There were no major events, internal or external to the organization, during that time period.

The interview schedule collected data on a variety of topics, some of which are not part of this study. Some of the relevant sections include:

1. Tracing the adoption of a best practice from another unit. Illustrative questions included a description of the best practice, why it was selected, where it came from, how it was identified, and the motivation to adopt. (The company used the term "best practices," which is equivalent to the discussion of problem-solution exchanges in this paper.)
2. Tracing a contribution. Illustrative questions included a description of the contribution, where it came from, how it was identified, and how it was motivated.
3. Alternative mechanisms for exchanging best practices. Respondents generated a list of mechanisms they use (e.g., informal meetings, training) for exchanging best practices, and rated this list and a standard list (e.g., company publications) in terms of their importance for best practice exchange.
4. Evaluations of the electronic library system (ELS). Illustrative questions included perceptions of this system in terms of functions, strengths and weaknesses, impacts on the organization, and so on. We also had the opportunity to use the electronic library system and review practices that were submitted and/or introduced into the system.
5. Measures of learning culture. A nine-item scale measured respondents' perceptions of knowledge sharing behaviors in and across offices (see Table 3). A six-point response scale captured levels of agreement (strongly agree to strongly disagree).

Two case environments

Two environments are described for examining the framework on CAS and organizational learning. The first is the CAS established by the company. The initial focus of this research effort was on this electronic library system (the computer-aided system) to facilitate the exchange of problems and "best practices" (i.e., solutions) across offices. A best practice is defined in this company as a solution that increases effectiveness indicators such as customer satisfaction, return on assets, etc.

The second environment includes several informal communities discovered in the process of doing this research. These communities used electronic and other communication mechanisms to share best practices.

Electronic Library System (ELS)

The ELS is an electronic library of best practices residing on an existing computer network that is accessible by all sites. The library

appears as a "folder" on an employee's desktop. The ELS was initiated by a senior manager responsible for product and service quality. It was designed by a team of managers and information system people. ELS was implemented and maintained by corporate headquarters. A flow chart of how ELS operates is depicted in Figure 3.

The act of contributing to the ELS involves filing a one-page "idea profile" as well as documenting performance benefits associated with the best practice to a corporate task force. The task force evaluates each best practice in terms of how well it is documented and the extent to which it contributed to the company's major business goals. In addition, each submission was reviewed by a process expert. If the proposed new practice was about billing, for example, it was sent to the person identified in the company to be responsible for this process. Accepted best practices are placed in the ELS. Other best practices may be sent back to the contributors for additional documentation or may be rejected completely. The evaluation process, including several requests for additional information, may take as long as 12 months.

An accepted best practice resides in the ELS as a written one-page summary of the idea, the action items, the business problem addressed, and the anticipated results. A contact name and address is also included with the best practice. Accepted best practices are categorized in a library index according to business problem area. In addition to the library of best practices, the ELS contains a folder with submission information. The contents of this folder are a blank submission form that can be downloaded and used by any interested employee, a description of evaluation criteria, and a list of corporate contacts who can answer questions. Finally, the ELS contains an online version of the "ELS Users Manual."

Potential adopters can access the ELS by clicking on the appropriate folder icon. The ELS is a read-only file maintained on a corporate server. Employees are free to copy the best practice library to their personal computer desktop in order to have a record of the best practice. Access to the ELS requires some pre-existing knowledge of the company's computer system and its network structure. If a relevant best practice were identified, the employee could follow up with the central office responsible for the ELS or the contributor of the best practice in order to get more detailed information.

The ELS illustrates the conceptualization of a CAS for organizational learning because (1) it permits adoption and contribution of solutions to problems across distributed units, (2) the system is known and accessible by other organizational members, (3) the library feature of ELS serves as organizational memory, and (4) organizational members can update the system with their experiences with particular solutions.

Distributed communities

In the process of interviewing, the existence of several geographically distributed groups that were organized to exchange problems and solutions was discovered. While all organizations have informal groups, these communities were different.

The communities were self-designed groups of managers from the same jobs (e.g., finance, quality) who had come together to exchange job-related information and best practices. They came into existence in the following way: Because the managers were in the same jobs and same regions, formal organizational activities brought them together. Through these formal interactions, they developed personal ties and a shared understanding of the need to share information over and above the formal communication requirements of their jobs. The communities, then, formed to exchange job-related knowledge among this small group of managers. The primary reason for a member leaving a community occurred when that person was given a new job assignment outside the region.

These groups used multiple media to exchange knowledge (e.g., phone, meetings,

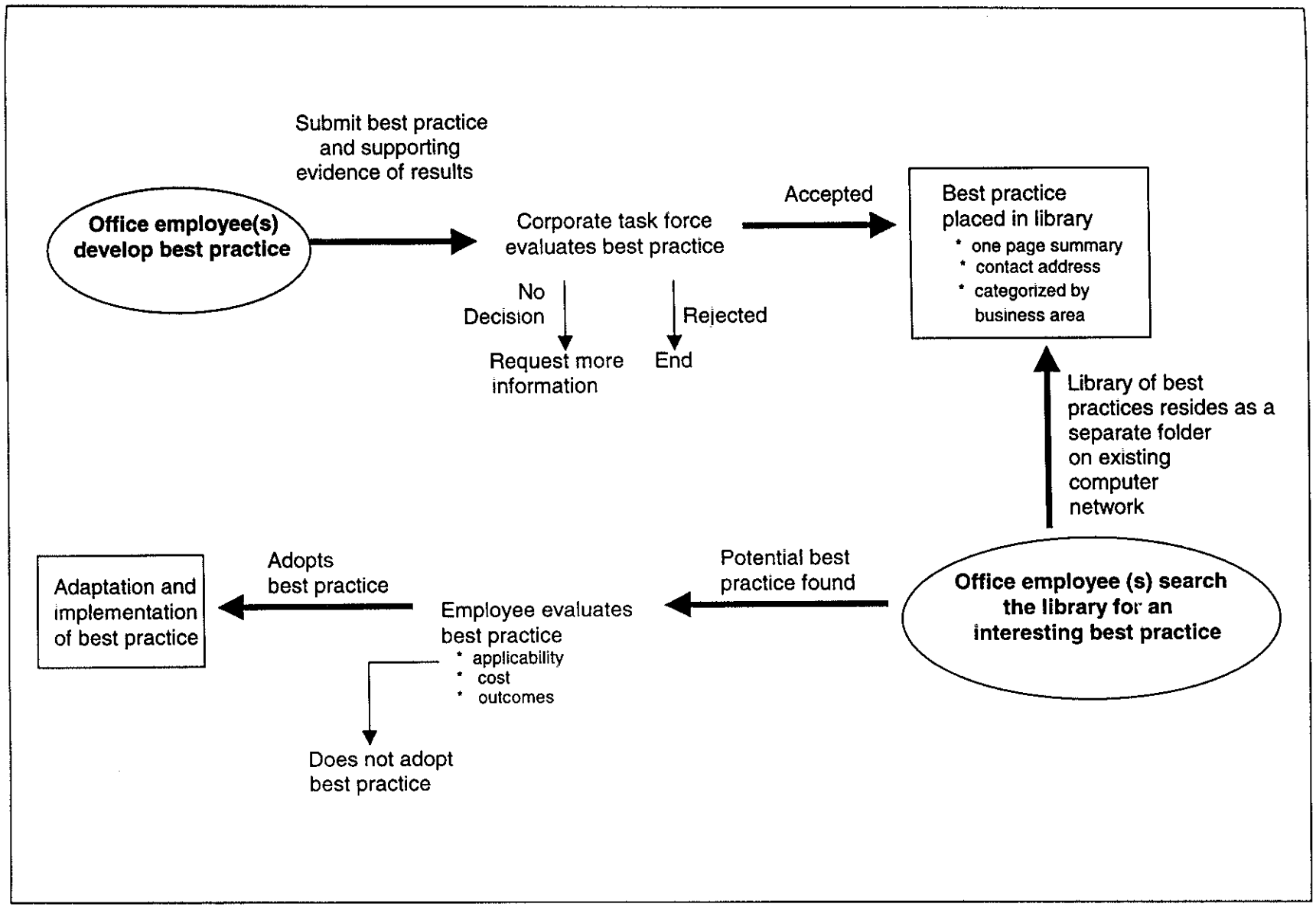

Figure 3. Contribution and Adoption Cycle for the Electronic Library System

e-mail, mail), and were structured in that there were regular face-to-face meetings, monthly conference calls, and the use of distribution lists. There were regular as well as on-demand communications. Some mechanisms required synchronous communications (e.g., conference calls), while others were asynchronous (e.g., e-mail). This is an information environment with multiple mechanisms that vary in richness and exhibit complementarity of form and function.

While others have written about the role of communities of practice in learning (Brown and Duguid 1991), these groups seemed distinctive in that they were (1) organized by the people in the same job category; (2) geographically distributed, but in the same regional area; (3) seemed to have fairly explicit norms about communication (e.g , monthly conference calls); and (4) were relatively small (six to eight members).

These communities were included in the analysis because they demonstrate many of the dimensions in the framework. They are engaged in organizational learning by exchanging problems and solutions. These learning processes occur in an environment rich in information technology and other formal and informal communication mechanisms. Within these communities, there also are mechanisms that facilitate matching problems and solutions and the indexing, storage, and updating of these exchanges.

Results

Comparing ELS and the distributed communities as organizational learning mechanisms

This section examines the theoretical framework in terms of these two cases. The analysis is organized around the two decisions: the decision to contribute and the decision to adopt. For each decision, the theoretical assumptions articulated earlier in terms of the following research questions are examined:

- How does the ELS (or distributed communities) reduce the costs inherent in the decisions to contribute and to adopt and enhance the incentives for these decisions?
- How does the problem/solution environment moderate the relationship between ELS (or the distributed communities) and the two decisions?
- How do other organizational context variables moderate the relationship between ELS (or the distributed communities) and the two decisions?

The decision to contribute within ELS and distributed communities

To aid in formulating a contribution, there was a simple one-page form in the ELS. This structure reduced some of the costs of contributing. However, the form by nature is passive and did not permit easy clarification of the information to be presented. For example, the submission process required demonstration of the best practice benefits. This task is both complicated and ambiguous (Goodman and Darr 1996). The connection between a specific solution and a benefit often is difficult to discern. Therefore, formulating a contribution and its benefits, particularly in problem solution environments with higher levels of complexity and tacit knowledge, requires assistance. There was no interactive expertise built into ELS about the formulation of benefit statements.

Another part of the decision to contribute is actually delivering the best practice. The ELS system was primarily text based. If an employee had a solution that he or she wanted to share, it would be typed on a one page "idea profile" or sent via e-mail to a task force that reviewed "best practices" before they were formally introduced into ELS. The problem with an asynchronous text-based system is that it limits the potential for communication. Some solutions which are more complex need to be portrayed in a multimedia form. Also, synchronous communications are often necessary for

clarifications. These features were absent in the ELS.

Another feature of the ELS was that each contribution was evaluated by a central task force. This process creates additional transaction costs, often in terms of requests for additional information. In some computer-aided systems for learning (Constant et al. 1996), contributions go directly to the adopters or to some form of organizational memory. The task force had each submission evaluated by a process expert. This increased the transaction time. Some of the interviewees who had contributed solutions indicated there were long lead times in getting an answer about whether a suggestion had been accepted, and sometimes there was ambiguity about why the suggestions were rejected. The following comments from the respondents capture this theme.

A service technician said:

> I submitted it [a service solution] because it worked well here. My boss also told me to do it . . . but when it came back, they had rejected it. It's not clear why . . . I was disappointed . . . and it took nine months to receive a response.

Other technicians capture the cost of contribution and the probability of a rejection:

> There is a lot of labor to filling out the forms. Also, there is a high risk that it won't get accepted.

> If we have a process here and it works, and it is rejected because we did not provide enough information . . . that's ridiculous.

The initial conclusions that can be drawn concerning the impact of the ELS on the decision to contribute are the following: (1) There are a lot of demands on people's time and contributing represents an additional cost. (2) The ELS uses very simple mechanisms to aid in formulating or delivering contributions. It is doubtful these mechanisms would work as problem complexity or level of tacit knowledge increases. (3) The ELS increased transaction costs primarily through its system for evaluating contributions. Respondents often did not understand the reasons for rejection and noted the delays in getting contributions approved. (4) There was nothing in the ELS system to provide incentives for contributing.

How did the distributed communities impact the decision to contribute? There were no formal mechanisms to aid in formulating contributions. However, while the community was geographically distributed, it was small (i.e., less than 10 people), people knew each other, frequently communicated with each other, and worked in the same job. These informal factors increased the probability that a contribution could be formulated in a way meaningful to other members in the community.

The delivery process in the decision to contribute was facilitated by the multiple communication mechanisms in these communities. There were formal face-to-face meetings initiated by the company; the community members initiated monthly conference calls plus daily e-mail and phone calls. This mix and frequency of communication mechanisms was capable of delivering problem-solution exchanges that ranged from the simple to the complex.

Another way the distributed communities were different from the ELS was on the benefit side. These communities emerged to exchange job related information and best practices. The contributions were initiated both by requests or volunteered into the system during meetings, so there was an overriding value that contribution to the community was important. Also, while the members were geographically distributed they had established personal relationships.

Decision to adopt within ELS and distributed communities

An adopter incurs a variety of costs. Initially, one must search to find possible solutions. The next problem is to match potential solutions with the problem at hand. Since there are many ways to represent problems and solutions, and since there are likely to be differences in language and conventions across distributed units, matching requires time and effort.

Differences across the geographically distributed units are captured by these comments:

> Machines react differently in different regions. I always turn to my own work group for ideas . . . we are in the same region. [Service Technician]

> There are so many variations between office to office . . . it's hard to share. [Service Technician]

Another problem for the adopter is to assess the quality of information that has been contributed. The following two interview comments represent views about the quality of information being submitted:

> Adopting . . . it's a way for me to get an order . . . I don't want people to buy from IBM I want them to buy from me The idea adopted was relevant and came from a credible source. [Sales Representative]

> Give people incentives [to share] There are no incentives now, so you just get people who want to blow their own horn . . . not the experts. [Sales Representative]

The benefits for adopting are very straightforward. There is some problem to be solved or organizational indicator to be improved. In response to why they adopt, some respondents said:

> We need to have better up times between service calls . . . so I look for ideas. [Service Manager]

> We've been overspending this budget by big bucks . . . we need to control it. [Financial Manager]

> We had a problem with a machine. It goes down intermittently . . . so I got some help . . . Why reinvent the wheel? [Service Technician]

How did ELS impact these benefits and costs? First, the ELS system was not accessible to people (e.g., sales) who primarily worked outside of the offices. When they did return to an office, often a machine was not accessible. Second, ELS is very much like a simple "card catalogue" library system. There is a very simple indexing system with general categories (e.g., sales, service) and subcategories. The user would select a subcategory and then scroll through the one-page write-ups. If a write-up seemed relevant, the user could contact the author of the solution or someone on the corporate task force for this system. The basic idea in this situation is that the search matching and reconfigurations are done by the user. There are no keyword searches or intelligence built into the system to aid in the search or matching.

Respondents' comments on the matching mechanism reveal a preference for more help in the system to reduce search costs:

> [They] need to improve key word access. If a customer calls and wants information about "X," I should be able to get some intelligent help from the system to get the information about "X." [Sales Manager]

> The problem [and solution] appear only on one page . . . it's a tease. You need supporting documentation. [Quality Manager]

The need for someone to help also appears in these comments:

> I'm not sure how to get into it [ELS] . . . I could have my secretary do it . . . someone like her goes in and inspects what's around and then shares it. [Office Manager]

> Every office needs someone like Mr. [name deleted] looking into the system and sharing with us what looks good [Marketing Manager]

A different cost—that of not finding anything in ELS—affects the perceived value of the system. One is less likely to look again or to contribute.

> I pulled up ELS and looked . . . but there is not much new . . . so I don't use it too much. [Manager]

> There's nothing in the drawer for me. [Manager]

The conclusion about ELS is that it did provide a potential population of solutions that were not accessible from the adopters' current networks in the company. Also, the benefits for adopting were relatively clear. However, there was no formal mechanism within ELS to make the search, matching, and configuration

process more effective. Respondents reported that there were difficulties in assessing the quality of information contributed, and inquiries into the ELS did not always generate solutions.

The adopters in the learning communities faced the same processes of searching, matching, and configuring a solution. However, these processes were simplified for a number of reasons. First, members of the community performed the same job in the same geographical region, so the problems they encounter and the language they use are likely to be more similar. Second, they had a shared memory through prior interactions. This shared memory can enhance the meaning and hence matching of problems and solutions. For example, if an adopter wants to solve a particular financial problem and another member of the community has a solution, in discussing this exchange, both parties can refer to past exchanges as a way to enhance understanding in the current exchange. The existence of shared past examples can enhance the efficiency and effectiveness of matching. Third, in these communities, multiple complementary mechanisms for exchanging problems and solutions were found. Because the participants for our study have a common job, there were frequent formal meetings. Inside and outside of these meetings, there were opportunities for face-to-face discussions and exchanges. There were regular monthly conference calls, which permit shared interpretation among all the members. E-mail provides opportunities for asynchronous communication. These complementary mechanisms provide a rich environment for searching, matching, or configuring solutions.

Problem solution characteristics as a moderator of the decisions to contribute and adopt

One basic theoretical assumption in this paper is that CAS or other mechanisms for learning are affected by the distribution of the problem-solution characteristics. It has been argued that exchanging problems and solutions is fundamentally a difficult task. The difficulty is related to problem-solution complexity and the degree of tacit knowledge embedded in the problems or solutions.

This organization sells many different types of products in different markets in the United States. Problems in sales, service, and financing vary across these products and markets. The overall distribution of problems and solutions seems heterogeneous in terms of complexity and level of tacit knowledge.

Respondents were asked to describe a critical incident of a successful adoption in order to understand the characteristics of problems and solutions in this environment. The analysis of this information first suggests there is a high

Table 1. Examples of Problem-Solution Exchanges

	Technical Problem-Solution	Sales Problem-Solution
Contributor	Service team in a Midwest office	Sales team in a Midwest office
Problem	Malfunction of a component	Sales for new product less than expected
Solution	Insert plastic part into component	Develop new presentation for product
Conditions	Problem cause and effects easy to specify	Difficult to specify
Number of Possible Solutions	Few	Multiple
Implementation Rules	Simple and easy to operationalize	Multiple
Results	Results for solution are immediate and easy to identify	Results for solution are difficult to measure and isolate

degree of variation in the complexity of problems within these work environments. Table 1 illustrates two problem-solution exchanges—one simple and one complex.

A second observation is that differences in problem complexity exist across functional areas. This point can be illustrated by describing the problem-solution features associated with each of the critical incidents (N = 69) described by the respondents. The problems and solutions adopted are presented by complexity and functional area in Table 2. Complexity was coded as high or low, based on the number of separate parts of the problem descriptions of the number of solutions.[2] The functional areas are service, sales, and administration. The basic result suggests that there is significantly more complexity in the sales than service area ($x^2 = 295.3$, $p < .001$).

A third observation about the problem-solution features in this organization is that there was wide variation in the ability to (1) articulate solutions and rules to implement solutions and (2) observe results from the solution. These two factors seem to vary if the exchange was about a technical problem (i.e., a problem related to a machine) versus a process problem. For the technical problems across all functional areas, it seemed easier to articulate solutions and rules to implement solutions. Also, the results were immediately observable. A technical problem in administration might be combining different file structures. Processes, whether they were from sales, service, or administration, seemed more difficult to articulate and more difficult to relate to measurable improvement. An example of a process problem in sales would be the procedure to roll out a new product (see Table 1).

How does this problem-solution environment, which seems heterogeneous in terms of problem complexity and tacit knowledge, interact with ELS? First, the ELS is basically an asynchronous communication system which primarily relies on text. It has relatively low capacity to transmit large amounts of information or rich information (Daft and Lengel 1986). ELS is capable of processing fairly simple problem-solution combinations, but not complex problems and solutions. Also, it is not designed to operate in a heterogeneous problem-solution environment. The classification scheme does not accommodate solutions which vary in complexity. Third, ELS was created primarily as a stand-alone system. It was not coupled with other mechanisms for exchanging problems and solutions. Therefore, ELS appears limited by its current design features.

The problem-solution environment within the communities is very different. First, these communities are composed of members of the same functional area (e.g., finance), job level, and region. Therefore, there should be more homogeneity in problem-solution features. Second, since members have the same job language and since they have rehearsed problem-solution exchanges in the past, exchanges over time may have less perceived complexity and may be easier to articulate. For example, assume there has been a successful

[2] Three independent raters judged the problem-solution complexity. Because normal distribution assumptions were not met, and because of the categorical nature of the variable, a non-parametric test was used to assess inter-rater reliability. A Kendall test was used to measure agreement among the three judges. A test statistic W = .838 was calculated, indicating significant agreement on complexity ratings ($X^2 = 25.07$, $p < .01$).

Table 2. Problem-Solution Complexity and Functional Area

		Complexity	
		Low	High
Functional Area	Service	32	3
	Sales	6	25
	Administration	1	2

exchange about a complex problem dealing with billing procedures. The next time a similar problem appears, there may be short cuts to frame the problem which, in turn, may lower the perceived level of complexity.

Third, the communities have developed a complementary set of communication mechanisms (e.g., conference call, face-to-face, e-mail) which have greater capacities to process large amounts of information and rich information. So not only may the problem-solution environment be more homogeneous and less complex, but the mechanisms for processing problems and solutions will be stronger as compared to the description of the ELS mechanism. The ELS was not a primary mechanism for exchanging in these communities.

Organizational context as a moderator of the decisions to contribute and adopt

The organizational context can play an important role in enhancing or inhibiting these two decisions. Three aspects of the organization were examined: culture, performance reward systems, and communication systems. Nine items were created to capture office culture about knowledge sharing in each office. Table 3 shows the percent of respondents either agreeing or strongly agreeing to each of the nine items. There were six response categories ranging from strongly agree to strongly disagree. The basic finding from this data is that respondents do not report strong norms supporting exchanges across offices. A total of 11% of the respondents said there were rewards for sharing with other offices, and 25% reported there was high cooperation between offices. The trends in this table are common across offices. That is, people report more cooperation within than between offices.

The reward performance measurement system in this organization was also examined. There were four very clearly defined and measured indicators (e.g., customer satisfaction, return on assets). These indicators were shared among all employees at all levels across the three offices. They focused people's attention and created a good deal of stress. One senior manager said:

> I don't have time to be thinking around here . . . to see what others are doing . . . these [pointing to a chart of the four indicators] are what I pay attention to.

Another important organizational dimension is the communication system. It can compete with or complement CAS involved in organizational learning. ELS was introduced into an environment with many rich mechanisms for exchanging problems and solutions. From a series of semi-structured questions, 17 different formal and informal mechanisms that were used in problems and solution exchanges were identified (Table 4). Formal mechanisms included company publications, toll-free numbers, benchmarking, formal meetings, and so

Table 3. Organizational Learning Culture Inventory

Item	% Agree and Strongly Agree
Sharing of BP in my office is highly rewarded	26
Sharing of BP with other offices is highly rewarded	11
Open communications in my office	57
My office is innovative	50
Sharing of BP is frequently discussed	40
Sharing BP is a major way to solve problems	57
High communication with other offices	20
High cooperation in this office	58
High cooperation between offices	25

Table 4. Communication Mechanisms

*Company publications	Phone calls
Non-company publications	Customers
Company Quality Days	*Networking within the company
Team Excellent Days	Networking outside the company
Benchmarking	*Formal meetings in the office
Company review process	Informal meetings in the office
Help desks	Formal meetings outside the office
Training classes	Informal meetings outside the office

* = Three most highly rated communication mechanisms

on. Informal mechanisms included phone calls or networking with friends. Respondents were asked to identify the three most important mechanisms for best practice exchange. The most frequently selected mechanisms are networking with company friends, company publications, and formal meetings in their office.

Some comments about these alternative mechanisms include:

> Networking with our sales reps . . . I know these people, how they approach customers . . . it can help me. [Sales Representative]

> Networking with friends in the company . . . they have been successful, they know the answers . . . there is a common bond. [Service Representative]

> In our team meetings, you are with other people who do the same things . . . we put an idea on the board and pick it apart . . . there are good ideas. [Sales Representative]

The common themes in these interview comments is that these communication mechanisms provide an opportunity to exchange with people you know and, hence, they are credible sources. In addition, the information is focused and relevant to the job at hand and therefore matching problems and solutions is easier.

ELS was infrequently mentioned. This is not surprising given the basic thesis that exchanging problems and solutions is a costly activity, and people will select mechanisms with which they are familiar and that have generated some previous success.

The distributed communities operate in the same organizational context. That is, they reported a similar office culture and performance requirements. The critical difference is that they are self-designed communities, organized to share information. In many ways they represent a counterculture to the existing organizations. Interviews with members of these communities indicate there are clear norms about knowledge exchanges and regular activities (monthly conference calls) to facilitate these exchanges. Exchanges occur in these communities because the culture and norms support these activities and buffer the members from the larger organizational context.

Discussion

This research investigated a CAS for organizational learning in distributed work environments. The ELS, while not state-of-the-art, did meet the necessary criteria to be called a computer-aided organizational learning system. It facilitated communication across time and space. It created a memory independent of any individual, and it allowed for searching for solutions and for updating of the memory. These criteria are useful for distinguishing true computer-aided learning systems versus systems that focus only on a single function such as search.

The features of the CAS (Figure 2) can play an important role in reducing the inherent costs in contributing and adopting. For example, formulating a solution that will be useful to others is a complicated task, particularly in a geographically distributed environment. It has been argued that features of the CAS can facilitate this process, and the complexity and level of tacit knowledge will affect the design of these features. In the case of ELS, solution prompting mechanisms were in place, but they were only capable of eliciting fairly simple solutions to simple technical problems. The issue was that the problem-solution characteristics were very heterogeneous, and the prompting mechanism did not match the heterogeneity. A similar case was made for the decision to adopt. There are inherent costs in matching problems and solutions, and features of CAS can play an important role in facilitating the matching process necessary for adoption. Delineating this intersection between the inherent costs and features of CAS is one contribution of this paper, which extends earlier work by others (Constant et al. 1996; Orlikowski 1993).

While features of the CAS are critical to reducing costs in the decisions to contribute and decisions to adopt, there also are functional equivalents. In the analysis of the distributed communities, a number of different features were pointed out. One important feature of these communities was that members worked in the same job in the same region. The communities had a similar language, similar experiences, and shared memories. If one's task is to find solutions to solve existing problems, this process of matching will be much easier with common languages and shared experiences. This feature of the distributed communities quite independent from the multiple communication systems or the self-designing nature of the communities provides a functionally equivalent solution to matching problems and solutions.

Another example may sharpen this point. In one office, a group of middle managers decided to meet monthly to review all the "best practices" (including those in ELS) submitted to the office and distribute them to the "right people." This filtering mechanism, which informally evolved, aided in the matching process and legitimated the process of sharing. This is a social filtering mechanism that is an alternative to a filtering algorithm that could be designed into a CAS. Understanding and identifying these functional equivalents has been somewhat absent in prior studies and remains an important issue for future research.

This research also illustrates how dimensions of the organizational context will play a key role in the level of knowledge exchange independent of CAS features.

When this study was initiated, sufficient weight was not placed on the importance of problem and solution characteristics. Also, this topic has been under-emphasized in prior work (Constant et al. 1996). The setting for this study was heterogeneous for problems and solutions. Some problems were quite simple to specify and were linked to solutions with few alternatives and clearly observable results. Other problems were quite complicated, and the associated solutions were multiple and not tied to observable results. Still other problems and solutions were high in tacit knowledge. This type of environment poses a number of issues. First, it may not be possible to design effective stand-alone computer-aided systems in a heterogeneous environment. Second, the CAS for learning may be better suited for homogeneous environments The commonality of the problems, tasks, and languages within the distributed communities was key to facilitating knowledge sharing The implications may be to design CAS for niched communities organized around a work area or process.

Third, in environments with high levels of complexity and tacit knowledge, an alternative model is to match adopters to specialized experts rather than to electronically stored solutions. Experts may be better able to interpret the problem statements and identify possible solutions. In the company studied, there were toll-free numbers where service people could contact experts about a particular machine. One could generalize this to experts in personnel, accounting, and so on.

The role of organizational culture and reward and performance systems played an important role. The point, which has been well documented in other studies, is that congruency between the CAS and the larger organizational culture is necessary for the technology to be effective. A culture supportive of knowledge exchanges across different units in the organization seems necessary for any form of CAS to be effective.

The fact that the organization did not have a strong learning culture is not surprising, since such a culture is hard to create in an environment of downsizing and short-term performance measures. On the other hand, the distributed communities represent an interesting alternative. They had a strong culture for learning, whose origin seems related to their decision to create a group for knowledge sharing. The key issue is that the communities were self-designed versus formally designed. Their culture for exchange seemed to exist independent of the broader organizational culture. The persistence of this culture may be related to the communities (1) being small, (2) not particularly visible to the larger organization, and (3) contributing to member work goals.

The contrast between ELS and the communities raised the issue of stand-alone versus complementary mechanisms for organizational learning. In any organization, there will be multiple mechanisms for sharing. In the communities, there were formal and informal and synchronous and asynchronous means of sharing. ELS was a stand-alone system. Since it was new and not coupled with other communication mechanisms, it is not surprising that people relied on more familiar mechanisms. In other accounts of computer-assisted systems for learning, the issue of embedding computer-assisted systems into alternative communication mechanisms is not fully addressed and should be a future research issue

In any study, there are obvious limitations. First, the focus of this study was on one organization that designed a fairly simple CAS that was not well accepted. There are many sophisticated CASs for learning. The focus in this paper, however, was not the specific features of ELS. Rather, the objective was to use ELS and the communities as a way to explore the inherent costs in the decisions to contribute and adopt, and how an information environment can mitigate these costs.

Second, it would have been useful to observe the distributed communities in action. This would have provided a richer picture of what they do and why they formed. Unfortunately, given the research relationship with the larger organization and how the communities were discovered, it did not seem appropriate to enter into their environment.

Conclusion

The demands to build effective organizational learning processes in distributed environments is likely to accelerate rather than decline. Rapid developments in information technology should contribute to enhancing organizational learning. However, the researcher and practitioner need to consider the major themes in this research, which are to (1) concentrate on the core decisions of adopting and contributing and the costs inherent in these decisions, (2) design future CAS to minimize these inherent costs, (3) consider functional equivalent mechanisms, independent of the CAS, for reducing these costs, (4) recognize the importance of characterizing the problem-solution environment prior to design any CAS, and (5) consider CAS for more niched communities than for the organization as a whole.

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