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Supporting Shared Information Systems: Boundary Objects, Communities, and Brokering

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SUPPORTING SHARED INFORMATION SYSTEMS: BOUNDARY OBJECTS, COMMUNITIES, AND BROKERING

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Abstract

Organizations increasingly rely upon integrated and shared information systems and databasessuch as ERP systems and data warehouses. Such shared systems pose new and unique support challenges for systems professionals. A review of the literature reveals that comprehensive models to study the support of shared information systems do not yet exist. Based on the theory of communities of practice, and on the concepts of convergence and divergence of systems and practice, the boundary object brokering model of shared information systems is developed. This model is applied to an interpretive case study of a large company, illustrating how shared systems can be seen as boundary objects that connect disparate communities of practice. The model and case study show how the traditional role of systems professionals has been augmented to include brokering tasks, providing new issues and implications for theory and practice.

1. INTRODUCTION

One of the dominant IT themes for organizations over the past decade has been the movement toward shared information systems and databases. The integration of separate and isolated "islands" of systems and data (Tapscott and Caston 1993) that began with smaller projects involving a few applications (e.g., payroll) continues today on a much broader scale with initiatives such as enterprise resource planning (ERP) systems and enterprise data warehouses (Davenport 2000). In addition, another common strategy of organizations has been to replace multiple systems that were local to each business unit, such as general ledger systems, with a single application that is shared by all business units. The goals of integration and standardization have significantly increased the likelihood that a single information system will be shared by multiple groups throughout the firm—spanning departmental and business unit boundaries.

The research portfolio of the IS scholarly community over the last several years clearly reflects an awareness of the importance of these shifts and the need to gain a better understanding of the set of technical and organizational issues that pertain to wide-scale integration and standardization. However, there is also growing awareness that research on these topics may require a new set of operating assumptions and conceptual models (Markus 2000). In this paper, we suggest that one area requiring new conceptual models is the *work of systems professionals in supporting shared systems*—the support that is provided following the initial introduction of the system through the end of its useful life in the organization. We contend that there are fundamental and important differences between the work of providing ongoing support for information systems that may be shared by diverse groups throughout an organization versus the work of supporting systems used by a single group. The purpose of this paper is to introduce a new theoretical framework to facilitate the understanding of the work of shared systems support. The framework is called the boundary object brokering model for shared information systems.

The model was developed from insights gained through an in-depth interpretive case study to investigate the role of IT professionals as internal knowledge brokers. Analysis of interviews of IT professionals at a *Fortune* 100 manufacturing and distribution company yielded insights into key issues related to the support of shared information systems. Communities of practice theory (Wenger 1998) provided the theory base for the study. Additionally, the concept of *convergence* (and *divergence*) between information artifacts and social worlds (Star et al. 1997) was incorporated into the model.

The paper begins with an initial discussion of the characteristics and challenges of shared system support. Next, the method for the case study is described, followed by the articulation of the model and supporting evidence from the case. The paper concludes with a discussion of some implications and directions for future research.

2. SUPPORTING SHARED INFORMATION SYSTEMS

2.1 Shared System Support: Definitions

The term *system support* used in this discussion encompasses all of the activities directed toward keeping an information system operational and responsive to users after it is installed and in production. For example, system support could include providing helpdesk assistance as well as changes to the software.

The term *shared system* is used in this paper to mean an information system that is used by multiple communities of practice. Such systems typically span formal organizational boundaries such as functional departments and even business units. Communities of practice are essentially informal structures: they are emergent and define themselves through engagement in practice. It is important to note that the boundaries of communities are not congruent with the boundaries of formal organizational structures such as business units, work groups, and teams (Wenger 1998).

2.2 Characteristics and Challenges of Shared System Support

The work of shared system support occurs within a complex organizational context. Shared information systems are larger in scope and more complex than systems that are not shared. Shared systems reach into diverse corners of an organization, supporting beginning-to-end business processes that incorporate the requirements of multiple groups. Shared systems are large in terms of the number of subsystems, users, functions provided, options, and customized features. In addition, the number of stakeholder groups that share these systems may also be large. Consequently, supporting shared systems requires IT professionals to have comprehensive technical knowledge and to understand aspects of multiple business contexts.

The level of interdependence among the components of shared systems may be high despite system design strategies of modularity and low coupling/high cohesion of system components that are employed to reduce system complexity (Briand et al. 1999). Shared information systems may also create connections and interdependencies among stakeholder groups that are not linked in any other way.

Maintaining shared systems is challenging because triggers for system change may originate in any of the stakeholder areas when work practices or requirements change. Change may also be triggered in other areas of the organization or from outside the organization.

Each of these sources of complexity helps to distinguish shared systems from those that are not integrated across functions or stakeholder groups. The complexity of shared systems carries important implications for IT professionals who support shared systems. The implications investigated in this paper deal with the demands on and opportunities for IT professionals to function as brokers, using shared systems as boundary objects.

2.3 Prior Research Related to Shared System Support

A review of prior research reveals a lack of research directed explicitly toward enhancing our understanding of the work of ongoing support of shared information systems. However, at least four active areas of research exist that could potentially inform this topic: shared systems development, system maintenance, technology/organization adaptation, and ERP research.

Identifying and including multiple stakeholders during the analysis and design of a system, and integrating and reconciling their perspectives, has been one of the central concerns of system development research. Examples of this large body of work include approaches such as joint application design and participatory design (Carmel et al. 1993); user viewpoint modeling during

requirements definition (Darke and Shanks 1997; Easterbrook and Nuseibeh 1996); tools such as the WinWin system for requirements negotiation (Boehm et al. 1998); and the Multiview2 methodology (Avison et al. 1998).

While much of the research related to information system maintenance has focused on the maintainability of software artifacts in terms of their modularity, measures of cohesion/coupling, in-line comments, and other features (Kim and Weston 1988), other work in this area takes a broader perspective (Edwards 1984; Swanson 1999). Martin and Osborne (1983), for example, view information system maintenance encompassing the full suite of activities directed to keep a system operational and responsive to users after its initial deployment.

Perhaps the most direct link between existing research and the topic of shared information systems support is research that investigates the mutual adaptation of technologies and organizations and the patterns of adaptation that may occur over time (Leonard-Barton 1988; Orlikowski et al. 1995). For example, Lassila and Brancheau (1999) have introduced a theoretical framework of discontinuous change patterns for commercial software packages and organizational processes.

Emerging work on ERP systems may also provide insights into the general case of shared information systems because ERP systems are designed to integrate organizational functions. Although the majority of ERP systems have not been in place for extended periods of time, some research has begun to explore topics related to ongoing support of these systems (Eriksen et al. 1999; Gable et al. 1998; Glass and Vessey 1999). It is clear that ERP systems are not "one-shot" projects and require ongoing attention to enhancements and new versions.

Although each of these four research areas potentially contributes to our understanding of the work of supporting shared information systems, additional work is needed—especially the development of theoretical models and empirical studies. The dominant focus of prior research on the development and initial deployment phases of an information system must shift to incorporate the full system life-cycle from conception through retirement. In the next section, we introduce theoretical concepts relevant to these concerns.

3. THEORETICAL FOUNDATIONS

The theoretical basis for the development of the model was formed by the theory of communities of practice and the concepts of convergence and divergence. Three concepts from communities of practice theory (Brown and Duguid 1991; Lave and Wenger 1991; Wenger 1998) were central to the development of the model: *community of practice, boundary object,* and *brokering*.

A *community of practice* is conceived as an informal aggregation of individuals engaged in common enterprise. A community of practice is characterized by the shared manner in which its members act and how they interpret events. *Practice* provides the source of coherence for a community and includes both the explicit and the tacit:

> It includes the language, tools, documents, images, symbols, well-defined roles, specified criteria, codified procedures, regulations, and contracts that various practices make explicit....But it also includes all the implicit relations, tacit conventions, subtle cues, untold rules of thumb, recognizable intuitions, specific perceptions, well-tuned sensitivities embodied understandings, underlying assumptions, and shared world views. (Wenger 1998, p. 47)

An organization may be viewed as a collective of communities of practice, each community having its own local perspective or "world view" (Brown and Duguid 1991).

Boundary object is a term coined by Star and Greisemer (1989) to describe objects that serve as an interface between boundaries of domain knowledge. Within communities of practice theory, boundary objects are defined as

> artifacts, documents, terms, concepts, and other forms of reification around which communities of practice can organize their interconnections....They enable coordination, but they can do so without actually creating a bridge between the perspectives and the meanings of various constituencies. (Wenger 1998, p. 107)

Brokering also provides a connection between communities of practice. Brokering includes activities by individuals that involve facilitating transactions and the flow of knowledge between communities of practice. Brokering

> involves processes of translation, coordination, and alignment between perspectives. It requires enough legitimacy to influence the development of a practice, mobilize attention, and address conflicting

> interests....[Brokers] are able to make new connections across communities of practice, enable coordination, and—if they are good brokers—open new possibilities for meaning. (Wenger 1998, p. 109)

The concepts from communities of practice theory were felt to describe the activities, processes, and context for the support of shared information systems by IT professionals. However, one additional concept was incorporated into the model to convey an important dimension of the relationship between the communities of practice and the shared information system. The concept of *convergence* was included to describe "the double process by which information artifacts and social worlds are fitted to each other and come together...a process of mutual constitution" (Star et al. 1997, p. 4). In their discussion of convergence, Star and her colleagues also comment that "social world," a term in sociology first coined by Strauss (1978), is "cognate with the notion of community of practice." In this study, convergence was taken to signify the ways in which a shared information system and related artifacts are fitted to and support each community of practice. Conversely, *divergence* between system and practice is viewed as movement away from fit toward incompatibility. Convergence, thus, becomes one of the primary objectives of the IT professionals supporting a shared system, and boundary object brokering is the label given to the activities and processes directed toward achieving a convergence of boundary objects with the set of communities of practice that they connect.

4. METHOD

The organization studied was a manufacturing and distribution company, given the pseudonym M-DCo, with approximately 55,000 employees and more than 600 plants, mills, distribution centers, and facilities throughout North America. Organizational alignment of the IT function followed a variation of the federal governance model (Brown 1997; Sambamurthy and Zmud 1999). The central IT organization (support for corporate and enterprise-wide systems and IT infrastructure) reported to the CIO. IT support for business units reported to the vice presidents of those units.

The philosophical paradigm underlying the study was constructivist-interpretive (Denzin 1998; Schwandt 1998), and the research strategy was an in-depth case study of a single organization. Communities of practice theory framed the research area, brokering by IT professionals. Data was collected via semi-structured interviews with 23 IT professionals at M-DCo's corporate headquarters. Interviews were approximately one hour in length and were tape-recorded and transcribed. The individuals interviewed were from both the corporate and the business unit IT groups and represented a wide range of job responsibility levels (see Table 1).

Table 1. Summary: Informant Characteristics

No.	Type of Organization	No.	Job Title
8	IT Support—Corporate Systems	3	Group Director, Information Resources
7	IT Support—Divisions	1	Vice President, Human Resources
5	IT Support—Human Resources	7	Director, Information Resources
1	IT Strategy Planning and Design	5	Senior Manager, Information Systems Development
1	Y2K Projects	3	Manager, Information Systems Development
1	Human Resources—Corporate	2	Lead Analyst
		2	Business Systems Consultant
Total = 23 informants			

Analysis of the data proceeded in accordance with the principle of dialogic reasoning (Klein and Myers 1999). (Table 2 provides an overview of the steps in the data analysis process.) Dialogic reasoning describes the process in interpretive research in which investigators subject their data to a variety of potential interpretations rather than settling upon a few *a priori* views. In the present study, the researchers began with a knowledge of Wenger's theory of communities of practice and an interest in seeing how IT professionals interacted with stakeholders' communities of practice. However, the researchers also recognized the limitations of Wenger's theory in guiding empirical research. Hence, the research objective was to extend the theory in useful ways rather than to remain true to all aspects of the theory. As the research proceeded, it became clear that the linkages between communities of practice would be one meaningful extension of the basic theory because Wenger's discussion of brokering among communities of practice is limited. The concepts of convergence and divergence were introduced as the research proceeded. The analysis moved in dialogic iterations between data and theory, eventually producing a model that was both based in prior theory and that extended this theory. In other words, the research process was neither entirely deductive nor entirely inductive.

Table 2. Steps in Data Analysis Process

- **Phase I: Data analysis conducted in parallel with data collection—analysis of individual interviews**

  1. Hand notes taken during the interview were reviewed immediately following the interview, and margin notes were added.
  2. Interview tapes were transcribed by the researcher, and observations or insights that occurred during the transcription process were noted.
  3. Interview transcripts were read and margin notes added to the transcript documents.

- **Phase 2: Data analysis following data collection—analysis of the set of data from all interviews**

  1. Identified an initial list of major themes and patterns observed in the data during Phase 1.
  2. Coded interview data using constructs from communities of practice theory. (34 constructs were identified as a central concept in at least one segment of the interview data. Constructs occurring most often in the interview data were brokering, boundary object, and knowledge.)
  3. Identified a final set of major themes and patterns.
  4. Examined the themes in the context of communities of practice theory. In some cases, there was strong alignment between the theme and existing theory. In other cases, the existing theory was inadequate in describing the theme and the analysis approach using dialogic reasoning was applied.

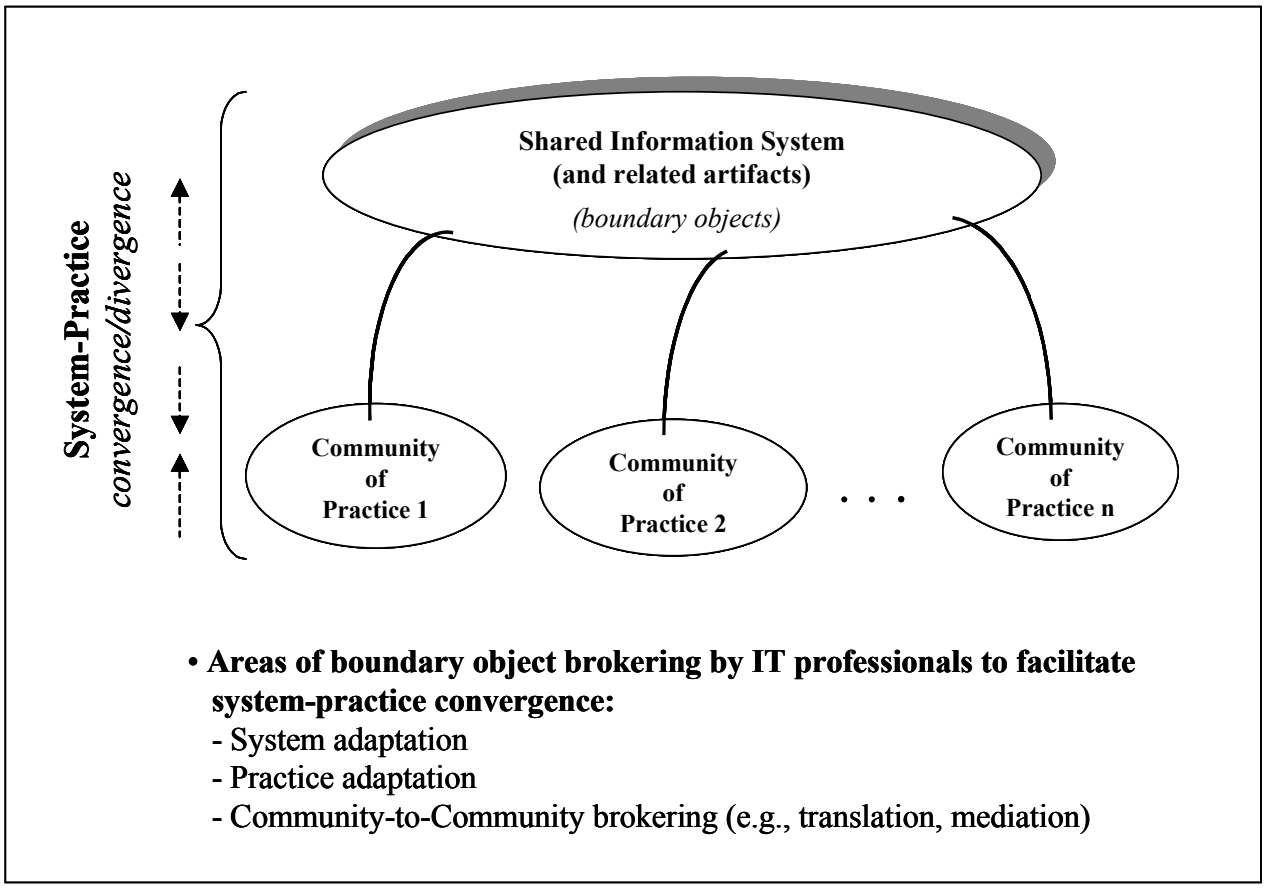

Figure 1. Boundary Object Brokering Model for Shared Information Systems

5. RESULTS

The boundary object brokering model for shared information systems is shown in Figure 1. The purpose of the model is to portray key aspects of both the activities and context for the support of shared information systems by IT professionals. The information system is shown as a boundary object, shared by multiple communities of practice. Artifacts related to the information system (e.g., system documentation, user training materials, standards, policies) are also shown as boundary objects that are shared by the set of communities.

The multiple stakeholder groups of the system are shown as communities of practice. For example, a human resources system might be used by the community of payroll clerks, the community of employee benefits counselors, and the community of budget analysts throughout the organization who use the system to track manpower costs for their departments. Conceptualizing stakeholder groups as communities of practice draws attention to each community's local world view and the role of the information system in each local community's practice. The convergence of system and practice is an issue for *each* stakeholder community. For example, a change to the information system may facilitate system/practice convergence for one community, while creating divergence for another community.

The model shows three areas for boundary object brokering activities by IT professionals to facilitate system/practice convergence: (1) adaptation of the system, (2) adaptation of the practice(s), and (3) brokering between communities (e.g., to facilitate understanding and joint problem solving). A single organizational issue may require a combination of brokering activities—system changes, practice changes, and mediation between stakeholder communities.

Interviews with members of M-DCo's senior IT management team support the general thrust of the model. For example, the following comment shows an appreciation of the significance of shared systems and IT's role as knowledge broker among the manufacturing facilities, each comprising a separate community of practice:

> Because [the mills] are kind of all over the place, and we have this core integrated system that everybody's using, and certain standards come out from corporate.…[The Senior Information Resource Manager's] job is to keep everybody on the same page.…Each one of these communities that we talked about has a different culture…as far as their language. And you have to constantly adjust.…When you have the business communities in the mills, it changes. They just have different expectations. And your approaches have to be different. Because each one is a little sub-culture of its own....They're in their own worlds so you have to work at it. *(Director, Information Resources and Senior Manager, Information Resources)*

Additional interviews with members of M-DCo's IT staff support specific components of the model. One strong pattern to emerge during analysis was the tight coupling between the brokering activities of IT professionals and IT boundary objects, particularly around information systems and related artifacts shared by multiple communities of practice in the organization. The descriptions of activities in support of shared information systems by IT professionals at M-DCo represented each of the three types of brokering processes identified by Wenger (1998).

Translation, defined as the process of framing elements of the "world view" of one community in terms of the perspective of another community, was manifest in the following comment:

> Legal will explain things from a legal perspective and use a lot of legal acronyms, jargon, terminology. Risk may not fully understand that. It's a good idea to make sure that a translation is occurring. And then in some cases even come up with sometimes a third way of saying it so that translation isn't required—it's common English language....That isn't always the outcome. But if it can be, that's even better. But at least come up with translations that each understand. *(Senior Manager, Information Systems Development)*

Coordination is defined by Wenger as the process of bringing perspectives to a state where communities of practice are not working at cross-purposes. At M-DCo, coordination was evident in an IT manager's characterization of his impact on the organization:

> The impact that I have on the organization…this always sounds so holistic…it's really just vision. I can take all the different thought processes that I attach to …. I'm attached to all the thought processes at [*the CIO's*] level…at the [*IT*] Utilities folks' level…the different directors that I deal with…obviously all the folks in my organization. I deal with 14 vice presidents and their thought processes. All of that. Very few people get a chance to work with [*the CEO*], to work with [*the CFO*]. I meet with [*the CFO*] on a regular basis....And the thing that I can take away from that is the thought processes from all these people…what they're thinking

> about…what they're talking about…and I can gel that into a need…and then what can we do to deliver that need—from a systems perspective. *(Group Director, Information Resources)*

Alignment is the process of relating the enterprise of the community of practice to a larger context of meaning—enlarging the view—so that the energies of multiple communities can be directed toward a common purpose. A business systems consultant provided the following reflections on the role of IT professionals:

> From my perspective, the role that we have in this profession is that we have this broader level of knowledge about the impact of the things that we're doing. In that when we're dealing with the user community, or customers, or whatever you want to call them…they tend to look at things in a very narrow way at certain points in time, and they don't see the ramifications of a lot of the things that they're doing. And so what I see is that we try to bring that perspective to them, to open it up…to make sure that they're aware of a lot of different aspects of things. *(Business Systems Consultant)*

A good example of a shared information system at M-DCo was an environmental information system that was shared by communities of practice composed primarily of engineers, lawyers/lobbyists, and auditors. The system encompassed a variety of environmentally-related sub-systems, e.g., air and water quality monitoring and reporting, tracking of hazardous materials used in manufacturing processes and products, and information related to environmental regulation and legislation. Support for the environmental information system was particularly challenging due to the mix of stakeholders. There were few interactions among these communities except for those due to their shared use of the system. Shared use placed members of the supporting IT group in the role of intermediaries among these groups.

Interviews illustrate some of the challenges faced by the IT professionals who supported the environmental information system as well as some of the actions they employed. A central issue for this set of professionals was the need to learn the practice of each community. For example, one respondent commented on the challenge of learning via training programs offered by the business units:

> Of course, there's also education from them to us on the business. And asking them "Can we come to your training sessions?" "Can we come to environmental regulation training sessions?" "Can we go to a water session?"....It is extremely specialized…very difficult to learn this. And we'll never be experts at it, but we'll certainly at least be knowledgeable. And I have some folks out here who have more knowledge than others…based on the previous projects they worked on. *(Manager, Information Systems Development)*

Because the problem domains for environmental systems were complex, learning practice entailed not only learning about these domains from a general perspective but learning about them as they are specifically instantiated within M-DCo. Entrée to practice by the IT professional is an important aspect of that learning process, and communities may vary in their willingness to provide that entrée.

A related theme evident from the interviews is the breadth of view possessed by the IT group, spanning both the informal boundaries of communities and formal organizational boundaries. In a company like M-DCo with a strong decentralized culture, IT professionals may be unique in their access to this extended perspective. The following two excerpts illustrate IT professionals' awareness of their role in spanning communities of practice:

> What these people don't necessarily realize is [the IT group] sees across this organization…I see data way across this organization…I see data from an enterprise perspective. I don't have the boundaries of their department.

> …in this company…we're decentralized…we don't communicate well. And we work in silos. [The Information Technology group] has ultimate responsibility *and* the ability to communicate across those department boundaries....That's my responsibility…at least that's the way I see it. *(Manager, Information Systems Development)*

In addition to learning the practices of the different stakeholder communities, members of the IT group developed their own characterizations of the communities and the types of individuals who populate those communities. The interview excerpts also show that members of the IT group have developed different strategies for working with the different communities.

> The most difficult group to work with a lot of times are the engineers....It's black and white…very black and white. And they have a hard time getting past the data....And so it's been an education on my part in how can

> I find ways to work with these folks.…What we've done, we've come up with prototypes that are somewhat working prototypes…they can't actually change data, but we'll put data on the form. And we'll get that directly from them. It's exactly how they want to see the data. So it gets them past that piece of it. So they can start to look at it and say "No, I'd really like this up here." And we've had a moderate amount of success with that. *(Manager, Information Systems Development)*

Finally, IT professionals were aware of the environmental information system as a boundary object that linked communities of practice together. This required more than just understanding differences in the language and world views of the different communities. Brokering through the boundary object of the shared system meant getting members of one community to understand and accept changes in their work necessitated by changes in the shared system that were needed by another community.

> There have been occasions when changes have been made and requested by other groups, that has impacted the Audit System. And so typically I've got *X* who's the director over there, and *Y* who's one of the auditors, and I've got *Z* who's an engineer…an air engineer…and I've got to get them into the same room. And they don't talk the same language. They don't even like each other. This group has a hard time communicating, anyway. They're not great communicators. And they will even fully admit it…that they're not good communicators. And so many times we've got to get them in a room.....And there are times when we go round and round and round and round. And finally we'll say, "Okay, enough. We'll come up with a different solution to this if you guys can't come up with it. We'll do with something different." *(Manager, Information Systems Development)*

6. DISCUSSION AND CONCLUSIONS

The perspective of shared system support as boundary object brokering draws attention to a number of key issues for both practice and future research. The most important general implication of our analysis is that IT professionals enjoy a strategic position by virtue of their direct involvement in the development and maintenance of shared information systems. Because such systems act as boundary objects connecting various user communities of practice, IT professionals can enable knowledge transfer among communities. Although knowledge brokering is not among the traditional responsibilities of IT professionals, proliferation of shared systems places IT professionals in a brokering role.

The boundary object brokering model portrays important characteristics of the context of shared information systems support: the connections and interdependencies among stakeholder groups that are linked to a shared information system; the diversity of stakeholder groups and the distances between them; and the multiple sources for change and locations for adaptation. Although the model itself is parsimonious in the number of concepts explicitly included, communities of practice theory contains a rich set of concepts that can be utilized to understand and express different aspects of boundary object brokering. The model is also adaptable to other contexts. The set of boundary objects can be expanded to include multiple information systems. Convergence would then be viewed as the fit of a set of information systems to the practices of a set of communities.

One of the challenges for IT professionals is to learn practice—to acquire practice-specific knowledge as well as cross-practice knowledge. Because learning practice is a key issue during the development and ongoing support of systems, future research should investigate how learning occurs. The relationship of the IT professionals to the stakeholder communities of practice may also affect their ability to effect system/practice convergence through brokering activities. Wenger notes:

> Brokers must often avoid two opposite tendencies: being pulled in to become full members and being rejected as intruders. Indeed, their contributions lie precisely in being neither in nor out. Brokering therefore requires an ability to manage carefully the coexistence of membership and nonmembership, yielding enough distance to bring a different perspective, but also enough legitimacy to be listened to. (Wenger 1998, p. 110)

The IT professionals at M-DCo frequently referred to "being allowed in," "getting a seat at the table," and the importance of being trusted. Understanding the different forms that these relationships can take, the factors that may influence those relationships, and related issues such as the reconciliation of membership in multiple communities may lead to insights concerning the impacts of organizational alignment of the IT function, physical colocation of IT professionals with members of the stakeholder community, among others.

Another important area for future research is the investigation of the outcomes of brokering activities—the impacts of brokering on convergence. For example, what role does brokering play in the adaptation of practice? How do characteristics of the system—e.g., flexibility, loose/tight coupling of subsystems—impact the need for, the location of, and the outcomes of brokering?

In conclusion, shared information systems present unique challenges for the IT professionals responsible for supporting them, the communities of practice that they connect, and the organizations in which they are embedded. For many organizations, large shared systems such as ERP have become the most important and operation-critical systems in their application portfolio. Not only are these systems critical to an organization, but they may be longer-lived than their predecessors (Swanson and Dans, 2000). The substantial investment required to deploy these systems brings to the forefront issues of utilization, adaptation, and extension of the useful life of the system. The boundary object brokering model for shared information systems is a framework that can improve our understanding of these contemporary challenges.

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