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Computer-Mediated Inter-Organizational Knowledge-Sharing: Insights from a Virtual Team Innovating Using a Collaborative Tool*

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How does a team use a computer-mediated technology to share and reuse knowledge when the team is inter-organizational and virtual, when the team must compete for the attention of team members with collocated teams, and when the task is the creation of a completely new innovation? From a review of the literature on knowledge sharing and reuse using collaborative tools, three propositions are generated about the likely behavior of the team in using the collaborative tool and reusing the knowledge put in the knowledge repository. A multi-method longitudinal research study of this design team was conducted over their ten-month design effort. Both qualitative and quantitative data were obtained. Results indicated that the propositions from the literature were insufficient to explain the behavior of the team. We found that ambiguity of the task does not determine use of a collaborative tool; that tool use does not increase with experience; and that knowledge that is perceived as transient (whether it really is transient or not) is unlikely to be referenced properly for later search and retrieval. Implications for practice and theory are discussed.

How does a team use a computer-mediated technology to share and reuse knowledge when the team is inter-organizational and virtual, and when the task is the creation of a completely new innovation?

This is an important set of interrelated questions because of the increasing use of *virtual inter-organizational collaboration* and the development and diffusion of *collaborative technologies* (CT) to facilitate the collaboration process (Allen & Jarman, 1999; Coleman, 1997; Haywood, 1998; Lipnack & Stamps, 1997). Dow, Ford, Chrysler and British Petroleum are well-known examples of companies diffusing CTs to facilitate their work (Ferranti 1997; Hamblen 1998). A Gartner Group (1997) study went as far as to say: "Real-time collaboration use will change from virtually nothing to ubiquity by 1999" (p.26).

The use of CTs is fundamental to making virtual teams work. A CT, also referred to as a virtual workplace, should be able to record, at a minimum, the process of the group, an agenda, libraries of solutions and practices, different forms of interaction, meta-information (such as date, sequence, author of contributions), and provide shared information storage, access and retrieval (Ellis et al., 1991; Field, 1996; Ishii et al., 1994; Kling, 1991; Nunamaker et al., 1993, 1995; Romano et al., 1998; Thornton & Lockard, 1994).

Critical, then, for knowledge-sharing and reuse with CTs is that the CT includes not just a mechanism for exchanging information (such as e-mail), but a mechanism for creating a knowledge repository and a mechanism for accessing the knowledge repository. In this paper, we report results from a 10-month field study of an inter-organizational virtual engineering design team and describe how a CT is used with respect to knowledge-sharing. The two questions we address are: (1) When do members of a virtual, distributed, inter-organizational team designing an innovative new product use a CT to collaborate? (2) When and how do team members reuse the knowledge once it is shared in the knowledge repository of the CT?

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LITERATURE REVIEW AND RESEARCH PROPOSITIONS

The criticality of CTs to collaborative work has been well-recognized in the literature (see Eveland & Bikson, 1989; Galegher & Kraut, 1990; Hiltz & Turoff, 1993; Johansen, 1988, 1992; Olson & Atkins 1990; Rice & Shook, 1990; Romano et al., 1998; Schrage, 1990). Among the many factors affecting the use of CTs suggested by these studies, two are of primary concern to us in this study: 1) *experience* with the CT and 2) *task* being accomplished using the CT.

Experience with a CT is a critical factor because, typically, teams use face-to-face media to share crucial knowledge on the extant norms, habits, and political relationships, in addition to content (Ehrlich, 1987; Kraut et al., 1998; Markus, 1992; Perin, 1991; Rice & Gattiker, 1999; Saunders & Jones, 1990). Over time, however, teams have been observed to gradually adjust to conveying richer information through the collaborative tool (Hiltz & Turoff, 1981; Orlikowski et al., 1995; Walther, 1992).

In addition to experience, studies have also found that not all tasks that a team might undertake to accomplish its objective are best suited for use with CTs. Several theories provide foundations for this perspective: "information richness" theory, "social presence" theory (Daft & Lengel, 1986; Rice 1984, 1987; Short et al., 1976), and the task circumplex model (McGrath & Hollingshead, 1993). These theories argue that organizational information-processing activities are differentially supported by various media; the attributes of certain media match the information processing requirements of some activities better than others. Because of the kind of information they can transmit (nonverbal cues, etc.), some channels (face-to-face, videoconferencing, etc.) are particularly suited for tasks that are not analyzable, nonroutine, equivocal and involve manageable amounts of information. Nonanalyzable tasks that teams might perform include strategic direction-setting, brainstorming, and conflict resolution. For such tasks, the theories predict that, given the option, teams will opt to use what can be called "interpersonal" methods of sharing knowledge since such methods provide the most context-rich capability. The most personal of these methods is the face-to-face meeting. For distributed team members, dyadic phone conversations are not nearly as interpersonal, but they provide at least the opportunity to share information in a one-on-one setting with aural cues. In contrast to these interpersonal methods are computer-mediated collaborative tools that share the information with the entire team. Collaborative tools are generally considered less likely to be used for ambiguous tasks because their public text-based computer-mediated nature makes it more difficult to share the context-rich information needed to understand the task.

Sharing knowledge and putting the shared knowledge into a knowledge repository are an important start in knowledge-sharing and the basis for organizational memory (Davenport et al., 1996; Huber, 1991; Walsh & Ungson, 1991). The repository alone is insufficient, however. For shared knowledge to be meaningfully used, the knowledge needs to be coupled with mechanisms for organization, retention, maintenance, search and retrieval of the information (Stein & Zwass, 1995). Such mechanisms are often computer-based, ranging from simple keyword organizing principles to complex intelligent agents and neural networks that grow with the growth of the knowledge repositories (Ellis et al., 1991; Johansen, 1988; Maes, 1994). Common among all these mechanisms is that they are established at the outset of a project (such as keywords) and are not generally modified during use. Thus, the literature indicates that these mechanisms, if established at the outset to promote knowledge reuse, will generally succeed at promoting knowledge reuse.

Although past research has yielded these important suggestions for the use of CTs, the literature on the use of CTs identifies a whole host of individual, technology, organizational, and group process factors that can also affect the use of CTs in sharing and reusing knowledge (DeSanctis & Gallupe, 1987; Furst, Blackburn & Rosen, 1999; Hibbard, 1997; Rice & Gattiker, 1999; Sambamurthy & Chin, 1994). Because of the many factors that affect the knowledge-sharing and use process, we contend it is difficult to determine which conclusions from the literature apply in all situations. Others (e.g., Kraemer & Pinnsonneault, 1990) have made similar arguments.

One aspect of a situation that has been little studied is the use of CTs among highly creative teams. Most studies of virtual team knowledge-sharing have been conducted on teams working on defined tasks such as software development. We believe that the decision process for creating an entirely innovative design, such as is called for in "discontinuous technology developments" (Iansiti, 1995; Tushman & Anderson, 1986), is fundamentally different than making decisions about problems for which there is a known solution or process because the brainstorming is neither anonymous nor non-evaluative, the knowledge to be shared is highly contextualized and reliant on informal opportunities of physical proximity, and knowledge-sharing involves not just synthesizing information but dissecting and recreating that knowledge in fundamentally different ways (Allen, 1985; Davis, 1984; Kraut et al., 1990).

Given these characteristics of knowledge-sharing in creative contexts, conclusions about how CTs are used to share knowledge among team members with more routine tasks may not apply. For example, for creative tasks, the theories noted above all suggest that knowledge-sharing be performed face-to-face. However, for a creative design team, this would mean that most if not all their work be done face-to-face. Such a conclusion seems too extreme and negates the purpose of virtual design teams.

In sum, then, a situation that has particularly been under-studied is the use of CTs for knowledge-sharing among: