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In Situ Data Capture and Mobile Knowledge Management: Helping Technicians Share Case Stories

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Abstract

This paper describes a field study of knowledge sharing in mobile work settings, and examines how rich data capture in situ *can be utilized to improve knowledge management practices. An ethnographic study is being conducted of a heating and cooling services company, focusing on the exchange of case stories, which are messages that tell the particulars of occurrences, or courses of events that are directly related to work processes. Knowledge sharing processes are identified among field knowledge workers, back office staff, and customers. With knowledge gained from the ethnographic study, we provide system design implications focusing on how rich data capture in situ can be used to enhance the integration of knowledge management process into everyday work activities. Our study also highlights how knowledge management system must facilitate the social aspect of knowledge sharing, and recontextualize information appropriately for different audiences. This research enhances our understanding of how future mobile multimedia messaging technology can be used in the design of organizational knowledge management systems.*

Keywords: Human computer interaction, computer supported cooperative work, knowledge management, mobile computing

Introduction

It has been widely recognized that organizational knowledge, or intellectual capital, exists not only in documents, procedures, and statistical reports, but also in undocumented ideas, conversations, and community know-how (Nonaka and Takeuchi 1995; Stewart 1997). Informal knowledge sharing occurs in conversations and face-to-face encounters, which are hard to capture, store and organize (Schultze & Boland 1997). When work is both knowledge intensive and mobile, as in many organizations, the sharing of knowledge becomes more challenging. Not only does the environment become more dynamic and fluid (Shen & Shen 2001), so does the knowledge sharing process. This research is concerned with the design of knowledge management systems that support organizational knowledge sharing in mobile work settings.

Early research into the design of information systems by necessity adopted a repository view on knowledge and utilized a passive memory model. From this perspective, the design of collaborative systems is similar to database design. These early systems required users to report their work in a highly proscribed manner to enable the sharing of knowledge (e.g. questions and answers in Answer Garden, Ackerman 1994). The result was that these systems only shared explicit information in strictly defined domains. In recent years, mobile knowledge management has emerged as a research area. Systems have been implemented for news journalists (Kristoffersen & Ljungberg 1997) and service technicians (Fagrell et al. 2000), focusing on using mobile devices for anytime-anywhere information retrieval and access, task coordination and scheduling.

We propose that mobile computing technology can potentially become an important part of the knowledge management process, not only because of its ability to access information anytime-anywhere, but also its ability to enable the capture of information *in situ* for later use. We adopt the view that knowledge is deeply contextual, a theoretical approach that has a long history in cognitive and social science. Key points from the literature include:

1. Remembering is a constructive act, which not only requires active participation, but is also influenced by context (Bartlett 1932);
2. Knowledge is always situation-bound and cannot be studied and meaningfully discussed without taking context and environment into account (Suchman 1987);
3. Cognition can be better understood by looking at how people go about knowing what they know, and the environment in which the knowing is accomplished (Hutchins 1995); and
4. Learning is both a constructive process and social activity (Wenger 1998).

It follows from the above, that the design of knowledge management systems will ideally take into account *context*, where knowledge and meaning is developed. Theorists have recognized the importance of context in transferring knowledge in heterogeneous groups (Robinson & Bannon 1991) or across communities of practice (Wenger 1998), and in reusing organizational memory (Halverson & Ackerman 2003) (Lutters & Ackerman 2002). Capturing of context has been an important area in ubiquitous and pervasive computing research (Abowd & Mynatt 2000). Much research effort has been directed into automatic capturing of environments to inform computing devices "aware of" the context in order to provide appropriate information, e.g. (Abowd 1997; Want 1999); or to provide multimedia record of activities for later use, e.g. (Wiberg 2001). This research differs by focusing on capturing *context* for human-human knowledge transfer. *In situ* data capture recognizes the importance of the "knower", i.e. the person who does his job through practicing in the field. Equipped with mobile multimedia capturing devices, the knower captures rich boundary objects, which can be used to recreate context. Our understanding of context is not only from a computational perspective focusing on physical environment (Dey 2001); but also from social and organizational perspectives incorporating the organizational and social context (Dourish 2001).

Methodology

We have argued that rich data capture *in situ* can enhance knowledge transfer. Our main research question is how rich *in situ* data captured by mobile technology can be utilized to enhance the organizational knowledge sharing process. To explore this question we are conducting a three-phase study that follows the usability engineering lifecycle.

Phase 1: Theoretical framework development and requirements analysis – In this phase our aim is to understand current data capture needs in a mobile work environment, and how captured data are being used for knowledge transfer. An ethnographic study is being conducted at a field site, which will be discussed in detail below.

Phase 2: System instantiation and iterative prototyping – Based on the framework and requirements from phase 1, a system is being built that allows data capture *in situ* using mobile devices, and retrieval via the Internet (Jones 2000, 2001). Compaq iPAQ Pocket PCs with digital camera attachments and voice recording functions are used to capture data *in situ*.

Phase 3: Field Trial and Evaluation - Detailed evaluation of the prototype system will be carried out by a field trial. Assessments will be made on the impact of data capture *in situ* on organizational knowledge sharing, comparing the sharing of "case stories" between phase 1 and phase 3, which will be explained below.

Field Site

The field study is conducted at a company that provides fuel, heating and cooling equipment installation and service in central New Jersey. The company is a family-owned business for three generations with seven service technicians, four secretaries, two managers, two oil truck drivers, and a customer base of over 3000 residential homes. The study site consists of the company headquarters, its service vans and delivery trucks, and customers' homes. With one exception, all technicians, oil drivers and secretaries have 15+ years of work experience in the fuel industry.

Case Stories as a Unit of Analysis

An important unit of analysis in this research is what we refer to as "case stories". We define a case story as a message that tells the particulars of occurrences, or courses of events that are directly related to work processes. Similar to stories, a case story is told for a particular purpose. Different from other forms of stories, such as jokes, news, or notifications, case stories focus on work process experiences. Orr's (1996) pioneering research, which examined Xerox photocopier repair technicians in 1986,

showed how the exchange of "war stories", or what we call case stories, could help a 'community of practice' diagnose problems, circulate information, and celebrate identity. Despite Orr's work influencing the development of a number of mobile systems, understanding how to design for rich case-story data exchange is limited.

Data Collection and Analysis

We are currently conducting phase 1 of this research and preparing to go into phase 2. Focusing on sharing of case stories, we are currently identifying case stories and collect data on frequency of case storytelling; contextual information in discourse (qualitative analysis); interactivity in case storytelling; remember of case stories over time; and customer satisfaction and loyalty. At this stage, data collection techniques include participant observations and informal interviews. Observations and interviews are being recorded with field notes, digital pictures, voice recordings, and occasionally video. To illuminate system design issues, we have adopted an artifact-centered cognition perspective (Norman 1988, and therefore focus on artifacts that are currently being used in case story sharing. So far 50 hours of participant observation data have been collected. Our preliminary results will be presented below, focusing on the use of case stories in the field site.

Preliminary Findings

In this section, we report on initial findings primarily from the first phase of this research. Names and details of employees and customers have been modified to provide confidentiality. After coding and analysis of the current field study data, a triangular knowledge sharing process emerges among secretaries and mangers in the back office, service technicians in the field, and customers (see figure 1):

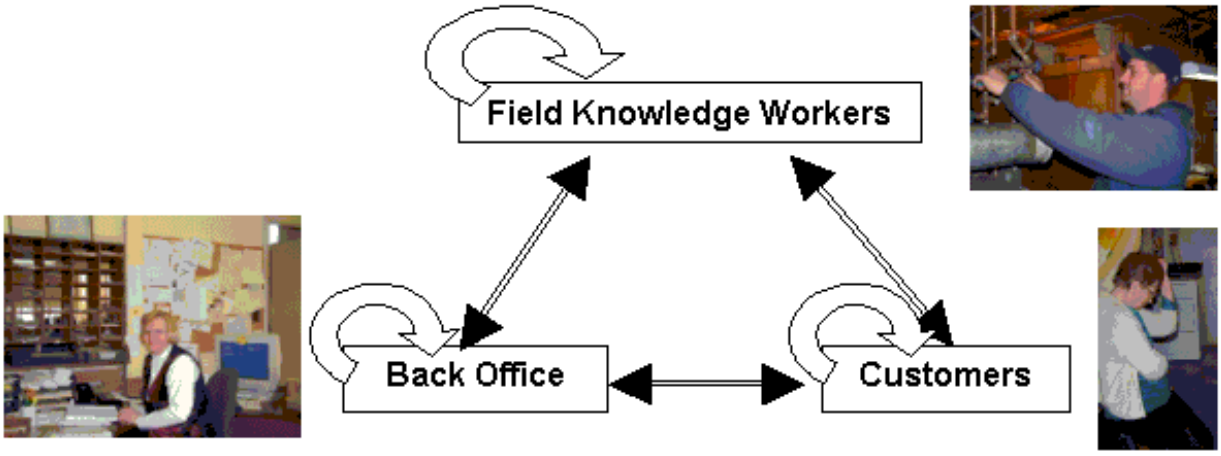

Figure 1. A Triangular Knowledge Sharing Process

Case stories are shared within and between groups. However, the frequency, format, and purpose of case stories vary. Below we analyze case stories from each group's perspective. Design implications will be discussed in the next section.

Back Office - The open floor office allows four secretaries to talk with each other easily and informally. Case stories are frequently exchanged to collectively build customer histories and to be able to provide personalized service to customers. The following illustrates this point:

> *Linda walks into office. Joyce says: "I just got this call from Mrs. Geller. She shouted at me for getting a $300 bill for oil delivery. She was really upset. Has she called before?" Linda says: "Is it Geller in Miller street? I know her! She has a big 500 gallon oil tank. Last time she called and asked us to deliver only 100 gallon*

oil. Some people just don't understand our minimum oil delivery is 150 gallons, or we will lose money on them!"

In this case, knowledge sharing happens through exchanging stories about customers. Sometimes the history about customers needs to be transferred to field technicians. In the above case, secretary Joyce tells the oil truck drivers to deliver only the minimum 150-gallons to Mrs. Geller. When customers call on the phone or walk into the office to ask questions about their heating and cooling systems, secretaries need to be able to explain the service job conducted by field technicians.

Field Knowledge Workers – Contrary to Orr's (1996) observation of Xerox repair people, storytelling happens only occasionally among technicians themselves. Three possible explanations are: (1) all seven technicians have at least 15 years of experience in their jobs and are able to finish jobs on their own; (2) most service calls are solo projects conducted by individual technicians; and (3) technicians spend most of their time on the road and in the field and do not gather together often. Instead of exchanging case stories that are as rich and vivid as those shared by secretaries, technicians rely on the service history information to conduct their repairs. As one service technician put it, *"Each boiler has its own characteristics. The service history tells you these characteristics of each boiler."* Currently, service history information, together with customer's name and address information, is printed on a service card by secretaries and given to technicians before they go out on their service jobs (see figure 2). In addition, a yellow tag hangs on each customer's boiler with service history information (see figure 3). In both cases the history is brief (date of service, abbreviated description of service conducted, and service technician's ID). Service technicians are expected to fill out a service card and a yellow tag each time after they finish their job. Despite the usefulness of the service cards and tags, technicians do not always update information.

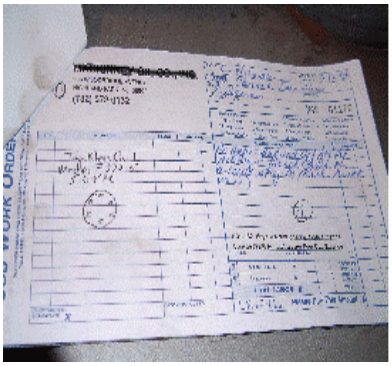

Figure 2. Service Card

Figure 3. Yellow Tag on a Boiler

Figure 4. Move-in-move-out Sales Call

On the other hand, technicians share different kinds of stories when they share information with customers. As Orr (1996) pointed out, a technician's job is not only to fix machines, but also to keep customers happy. One technician put it this way: *"Fixing boilers is important, communication with our customers so they know we fixed it is even more important."* Technicians use "sales calls" instead of "service calls" to stress that the nature of some of the services is to build a relationship and create trust in customers, rather than actually repairing equipment (see figure 4). The following example illustrates this point:

Bob, a technician, is in the house of a young couple, who are first-time home owners and just moved in. They reported their boiler keeps running out of water. Instead of directly repairing the boiler, Bob explains to the couple the heating system they use, the boiler and what to watch for if the water level is low. As they move from room to room to check the radiator and vents, Bob says "By the way, you have a very nice fire place. This used to be our party place in high school." "Really?!" the couple are surprised. "Yeah. The guy you bought this house from, Jeff, is my friend since high school. Jeff's dad built this house, and I installed the boiler for them!" Before Bob leaves the house, the young couple decides to sign up for a service contract with the company.

In the above example, stories are exchanged between a technician and customers to create a social relationship, and to transfer information such as the history of the house and the heating system.

Customers - As discussed in the above two sections, customers share case stories with secretaries and technicians to report problems, inquire about work progress, or to simply learn about their heating and cooling systems. Case stories are often told for social purposes, in addition to information exchange, as illustrated in the above example. Further, customers share case stories with each other to circulate information such as which technician is competent. For example, one customer says: "I called the office and asked for Mike to come and check my boiler. The secretary told me they have six other technicians. But I said I just want Mike. Last time he came, fixed the valves, and saved me money. I like him. He knows what he is doing."

Design Implications

Based on the findings described above, we discuss the implications for the design of knowledge management systems and summarize them from three perspectives. These are: (1) the integration of rich *in situ* data capture into work processes; (2) the facilitation of social processes; and (3) the appropriate recontextualization of data.

Integration of Data Capture in Situ into Work Processes

Research into mobile knowledge management (e.g. Fagrell et al. 's (2000) NewsMate system) suggests that system should be designed to support evolving work tasks and everyday activities. Our study build upon these ideas by suggesting that rich data capture *in situ* can enhance knowledge management systems by further integrating knowledge capture with work activity. Currently at the field study site pen and paper are used to capture data. Captured material is being used for various purposes, including archiving, prediction of problems, and task management among field technicians and the back office. Despite the importance of service history, data is often lost. If mobile technology has the same affordance as pen and paper, has the potential to be integrated into mobile work activity and improve knowledge management processes.

Facilitation of Social Processes

From the above analysis, we can see that knowledge sharing is a social process. Nonaka and Takeuchi's (1995) SECI model acknowledges this and describes the movement of knowledge between tacit and explicit states through the four processes of socialization, externalization, combination and internalization. Social processes cannot be replaced by technology. However they can be facilitated by carefully designed systems. Data capture *in situ* can enhance the process of knowledge sharing by providing rich data that can be recontextualized at a later point for storytelling. System design should try to facilitate the externalization (tacit to explicit) and socialization (tacit to tacit) knowledge processes so that case stories can be made explicit and shared.

Recontextualization at Different Levels for Different Audiences

This study highlights the extent to which different organizational roles leads to different needs for case stories. Case stories exchanged among technicians are more abstract while case stories shared to customers are richer in context. This suggests different levels of recontextualization are needed for different people in order to share knowledge. Ackerman and Halverson (1998) point out that information must be decontextualized for storage and must be recontextualized for use. Rich data capture *in situ* can potentially be recontextualized differently for different audiences, which will enhance knowledge transfer.

Current Status and Contributions

Currently we are primarily involved in theoretical framework development and requirement analysis. In addition, we are building the basic infrastructure for phase 2. We are working on the simple uploading of photos and voice recordings via wireless transmission, which are captured using iPAQ pocket PCs and iPAQ integrated digital cameras. A web interface is also being created for the retrieval of case-story related sounds, images, and text.

This study is among the first to investigate how rich *in situ* data captured by mobile technology can be utilized to enhance organizational knowledge sharing processes. This research increases our understanding of how to design systems that effectively use rich data captured *in situ* to enhance knowledge transfer. With the move from the provision of Short Messaging Service (SMS)

for text exchanges on mobile phones to Multimedia Messaging Service (MMS), the need for such design and usability research is becoming increasingly important.

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