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Exploring Support for Knowledge Management in Mobile Work

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This paper reports fieldwork from the electrical utilities industry, examining the suitability of current knowledge management perspectives to the day-to-day work of mobile staff. Reporting the results of the empirical study, we make a distinction between four aspects of local and mobile "knowledge management" as it took place in the mobile work setting: *sharing*, i.e., several parties exchange knowledge; *indexing*, i.e., one party explains to another what knowledge to retrieve; *diagnosing*, i.e., two parties make sense of how to interpret a situation, and; *foreseeing*, i.e., one party (or more) uses knowledge to project the future. We compare and contrast the empirical findings with current knowledge management perspectives, and outline an initial sketch of a framework for "practical knowledge management."

1 Introduction

Organisational memory and knowledge management have inspired important debates within the field of CSCW (e.g., Randall *et al.* 1996; Bannon and Kuutti 1996). This paper reports from an empirical study where these two issues were examined in the day to day work of mobile service engineers. The study also explored the concept of local knowledge since its importance has been much

recognised in the field (see, e.g., Rouncefield *et al.* 1994; Randall *et al.* 1996). Local knowledge has mainly been conceived as specific to place and procedures and the ways in which it appears in mobile work settings have not been investigated. Moreover, there has been a tendency, within CSCW, to localise activities to an individual user, and thereby missing to enhance the flexible and unexpected collaboration that often emerges out of a mobile work situation (cf., Luff and Heath 1998).

To collect empirical data we observed (Hammersley and Atkinson 1993) and interviewed the mobile staff (Patton 1990). The study lasted for about five months with an average intensity of two days per week. Large parts of the empirical material was transcribed and analysed according to the principles of grounded theory (Glaser and Strauss 1967).

Our analysis provides a critique that challenges some of the current conceptions of knowledge management, but at the same time gives opportunity for new mobile applications. We suggest a conceptual framework based on how knowledge sharing mechanisms map into action. Our point is that knowledge management in mobile settings is *social* and *dynamic*. It is this *social* mapping process that deserves our attention, although it may not in itself be suitable for computerisation.

The structure of this paper is as follows: Section 2 outlines the related work and is followed by the research background and setting. Section 4 presents an analysis of the fieldwork. Section 5 discusses the results, the related research and derives design implications. Section 6 concludes the paper.

2 Related Work

Organisational memory is an established theme in CSCW. Research contributions on the topic involve empirical studies, systems design, as well as conceptual debates. Organisational memory systems are typically based on hypermedia that links different sources of information, e.g., records. Recently, the notion knowledge management has been introduced into the CSCW field (cf., Greif 1998). It seems to have much in common with organisational memory. However, an emphasis on *managing large repositories of information* with information retrieval and artificial intelligence techniques can be noted (see, Abecker *et al.* 1998; O'Leary 1998).

One of the first organisational memory systems described in the literature was gIBIS (Conklin and Begeman 1988). The aim of gIBIS was to make decision processes explicit by capturing the argumentation.[1] Another system is "TeamBuilder," of which the objectives is to support team members in identifying expertise and collaborate more effectively (Karduck 1994). "Answer Garden"

[1] The gIBIS is now a commercial product called QuestMap (http //www gdss com/QM htm)

aims to help organisations to capture and enable retrieval of experiences made by their employees (Ackerman 1994). In "Answer Garden 2," there are also features for finding and interacting with experts directly (Ackerman and McDonald 1996).[2]

Under the knowledge management label, Terveen *et al.* (1993) report from a project of creating a "living design" for software developers. The system provides access to, and updating features of design-relevant information. More recently Edwards and Mahling (1997) explored design implications for knowledge management in the legal domain. In addition to their advice about putting knowledge "chunks" into organisational context, they suggest that roles should be assigned for assuring relevance, accuracy, and periodically review the material (similarly to library work).

Empirical studies on knowledge management have aimed at eliciting design implications, e.g., by analysing the work of a telephone hotline group (e.g., Ackerman and Halverson 1998) and expertise location in a software development company (McDonald and Ackerman 1998). Studies have also evaluated organisational memory systems in use (e.g., Ackerman and McDonald 1996).

The conception of an organisational memory has been criticised for diverging from remembering, as it actually takes place in organisations (Randall *et al.* 1996; Bannon and Kuutti 1996). A similar position is taken by Kovalainen *et al.* (1998) who sees organisational memory as an "artefact mediated process." Many ideas on the topic derive from the decision-making perspective on organisations. This perspective has been heavily criticised by, among others; March (1991) who argues that this is simply not the way things happen in organisations. Another issue is the uneasy relation between learning and memory. As Weick (1979) puts it: "to organise[3] is to reduce variety and remember but to learn is to keep variety and to forget " This type of learning, however, is of a different character then the less ambitious learning-by-doing that is mainly considered in this paper. Orr (1996) describes an example of this sort of learning where the staff of mobile photocopier repairmen uses stories to assistant the communities learning. To further explore this, we turned towards the concept *local knowledge.*

Geertz (1983, p. 167) views local knowledge from the perspective of "to-know-a-city-is-to-know-its-streets." Here, local knowledge could be similar in many different geographically dispersed workplaces, but *it is created through local experiences* and *used locally* by a limited group of people that are working more or less together. In CSCW, local knowledge has been described as: knowledge of the particularities (Rouncefield *et al.* 1994), what makes work run

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[2] Systems that link users with similar interests are also known under the label 'recommender systems' (see Foner 1997, Kautz *et al* 1997)

[3] Weick (1979) make a difference between organisation and organising arguing that the noun form encourages us to see the phenomenon as a static thing, whereas the verb encourages us to see the phenomenon as a dynamic process This is similar to the suggestion by Randall *et al* (1996) to shift from using noun memory to the verb remembering

smoothly (Randall *et al.* 1995), to know who knows what, who is busy, who is worth asking about "x" (Bowers *et al.* 1996).

The focus of this paper is the mobile work setting. Recently, it has been argued that there is a need to explore how mobility takes place in collaboration (Luff and Heath 1998). "Walking away from the desktop" means new problems and possibilities (Bellotti and Bly 1996). Luff and Heath (1998) identify three types of mobility: *micro mobility*, *local mobility* and *remote mobility*. Micro mobility is the way in which the artefact may by mobilised and manipulated for various purposes around a relatively circumscribed, or "at hand" domain Local mobility is more scattered, for instance, walking between rooms, floors and buildings at a local site, e.g., that of product designers at a consulting firm (Bellotti and Bly 1996), personnel at London underground (Luff and Heath 1998), bank officers at a customer service centre (Kristoffersen and Rodden 1996). Remote mobility is when remote users interact with each other using technology, e.g., construction foremen visiting work teams. The case study of dispersed and mobile IT support staff, described in Kristoffersen and Ljungberg (1998), involves both remote and local mobility.

3 Research background

Goteborg Energi (GE) is a publicly owned Swedish energy provider with approximately 900 employees and 3,000 million SEK (approx. 333 million *euro*) in yearly revenue. Every year GE provides just over 4,700 GWh electricity, 3,600 GWh district heating and 700 GWh of natural gas. Their 350,000 customers can be anything from a single flat to heavy industrial production facilities or sports stadiums.

A couple of years ago the Swedish electricity monopoly was disbanded and the market de-regulated. GE suddenly had to cope with more than a hundred suppliers instead of one and more competitors in the provider layer. As a consequence of this, the company had to undergo substantial organisational changes and become more customer-oriented than before, in order to answer to the competition and keep their advantage and market share.

3.1 Large scale introduction of GIS

GE is currently engaged in significant IT investment as a way of transforming the company. The old mainframe-based systems are being replaced with a client-server solution and much paperwork is computerised. One of the investments has been to computerise maps of the electricity network. This activity is finished and many kinds of information have been integrated with a Geographical Information System (GIS). One example of this is that 15,000 cable boxes, i.e., the connecting nodes for houses and streetlights, are represented in the graphical view of the

map. Additionally, information is provided about the cable box's components and to which customer's it is serving.

The GIS is accessible on the companies 850 networked PCs. The next step is to make it accessible for the 300 employees that do a majority of their work away from a networked stationary PC. The idea is to equip GE's 200 vehicles so that the GIS can also be accessed from the vehicles. The expected benefit of the mobile system is that less driving back and forth would be required to get information, e.g., maps, from stationary computers.

We followed a pilot project to evaluate the types of techniques under actual work conditions. A car was equipped with a laptop with network access via the Global System for Mobile communication (GSM)[4]. The laptop was connected to a colour printed making it possible to download maps and print them in the car.[5]

3.2 The local service station and roles

GE has several local service stations and they are responsible for a limited geographical area in which they are located. The responsibilities are for *installations, maintenance* and *error repairs*. The work assignments are generally distributed from the central administration office, but lately the stations' personnel have been allowed to initiate customer relations, which is a big change. They are also to a great extent autonomous at an operational level. There are three major roles at the station, namely electricians, planners and administrators.

Electricians work in pairs, mainly for security reasons, but also so that skills in both high and low voltage are represented. The work pairs get their assignments from the planner, but they often do the final co-ordination with the customers themselves. The work in the field generally involves planned work, i.e., installations and maintenance, but also emergencies, e.g., power failure, which has to be taken care of immediately. Almost all of the electricians at GE are on a rolling timetable for 24-hour on-call duty. In these situations they may have to operate beyond their ordinary geographical areas. The electricians have cellular phones and pagers as standard equipment.

The planner schedules assignments by allocating resources, such as personnel, raw material and vehicles. An important issue for the planner is to manage co-ordination with contract entrepreneurs that could be large construction companies or a one-man firm with a bulldozer. It is also the planner's responsibility to make security certificates of finished jobs and inform customers and neighbours of potential disturbances. The planner has an office in the main building with a phone and a networked computer. However, the planner uses his cellular phone

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[4] More information about GSM can be found at the GSM association (http //www gsm org/)

[5] To solve the problem of low bandwidth over GSM the server computer had software, which used data compression techniques and with the ability to store frequently displayed graphics on the client computer instead of repeatedly downloading them

very much since most of his working time is spent in the field. Constant communication is vital because of the need continually to change priorities. As a planner put it:

> We think we have control of the situation We have projects and deadlines. But we never do one job at a time. We have five or six assignments simultaneously. And then new customers call and want the electricity connected to their houses No matter how much work we have, we must do it within two days

Planners administrate complexity, and try to control resources that are constantly changing.

The administrators work in the main building. One of them does accounting, communication with the central office and takes care of the customer telephone calls. The other one mainly creates prospects for future installations in the area, e.g., new housing and industries.

The first thing that happens (about 7 am) on a workday is that most employees at the station meet, having an informal coffee break. They talk about the work and how it should progress during the week. Afterwards, assignments are divided among the work pairs (of electricians). The planner and the work pairs negotiate the division of work and decide how to proceed. When this is done, the cars are loaded with appropriate equipment. After this the pairs go to the customers that are at several geographical locations. If the schedule is not rearranged, they will return to the service station during the day. They will normally spend the afternoon doing some more work in the field, followed by paper work back at the office.[6] More time is spent in the field on bigger assignment on projects and maintenance. Figure 1 gives an overview of the staffs geographic distribution and roles.

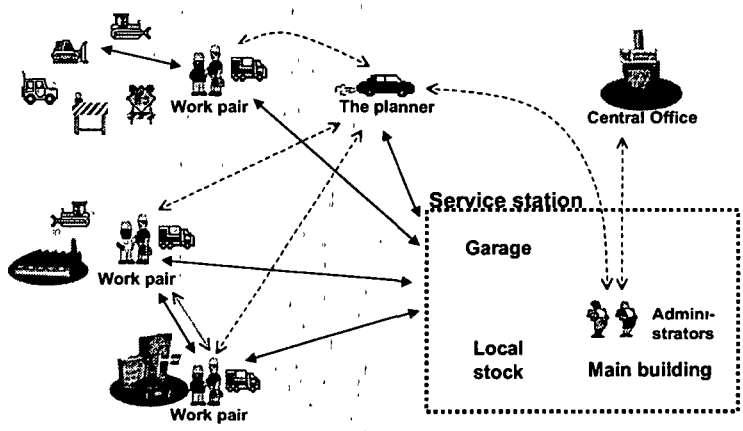

Figure 1 · The communication flow (dotted arrows) and the mobility of the workforce.

[6] Other systems, e g billing and order, where accessible, but not used in the mobile environment during the time of our study

Our observations consisted of following the electricians and the planner at the station, in the vehicles and in the field (see figure 1).

4 Results

Reporting the results of the empirical study, we make a distinction between four aspects of local and mobile "knowledge management" as it took place in the mobile work setting investigated. These are:

- *Sharing*: Several parties exchange knowledge.
- *Indexing*: One party explains to another which knowledge to retrieve
- *Diagnosing*: Two parties make sense of a situation, i.e., how it should be interpreted.
- *Foreseeing*: One party (or more) uses knowledge to project the future.

Let us now consider these types in more detail.

4.1 Sharing

We found three types of sharing, namely ephemeral, persistent and stories. The one categorised as *ephemeral* took place at the daily coffee meeting. When people meet they discuss their work. This is where they get updated and informed. The following paragraph is an example of an event that was repeated every morning with only small variances.

> The planner comes in and pulls out his agenda and starts to discuss some reorganisations of today's work. He throws out a couple of questions of what the work pairs are doing this day and how long they think that it will take

The planner tries to see if there is anyone that can reschedule today's program if something urgent comes up. Since this is a collective effort, the electricians gain knowledge of what their colleagues are doing. In many other studies the "talking out loud" and "overhearing" has been identified to give colleagues peripheral awareness what is going on and inviting the to give feedback (e.g., Heath and Luff, 1991). This mainly occurs during the morning meeting, but it was also observed at other places around the station. It makes it possible for the planner to call the correct work pair if a reorganisation is necessary. It is also useful for the electricians since they become aware of their colleagues' whereabouts in case they need to ask someone. If the planner calls them with a question or assignment they cannot answer, they may know whom else to recommend.

If someone knows something that concerns everyone, it is often brought up on the morning meeting, as the following example shows.

> George says so everyone can hear "There may be a need for more personnel at Tuve I was there yesterday .. it seemed like there was a lot of things that they would like us to do." [The others were listening and some nodded in agreement]. The planner takes a note and says that he is going to call them [the customer]

This helps the planner to plan ahead and it notifies the other electricians to prepare for what they might be doing next.

The formalised organisational sharing functions are to a great extent embedded in documents (forms and maps) that electricians fill in during and after assignments. We call this *persistent* sharing. These would then be sent to other organisational units, e.g., map surveyors and customer billing.

One example of how people share persistent knowledge was a *filer* the electricians used when they were on duty (during nights and weekends). When on duty, the electricians may have to visit sites where they rarely go, or have not been before. This could be problematic. For example, it could be difficult to remember details from time to time. It could also be difficult to get hold of people for assistance. To cope with the problem, the electricians have developed a (paper) *filer*. The *filer* is indexed by street address and contains information about local conditions of specific places. Some illustrative examples of entries from the *filer* are:

- *Karl Gustav's street 22-30: "The cable box is behind the basement door in the backyard of Engelbrekt's street 45."*
- *Erik Dahlberg's stairs: "Call the janitor on 111 22 33 to get the key to entrance 5. In case of no answer call the FM housing centre on 111 44 33."*
- *Viktor Rydberg's street 42: "The box is in the heating room. The key is in the cupboard and its got a wood piece on the ring."*

The content of the *filer* is designed to provide information that is relevant for on-call duty work. It bridges some of the representational shortcomings of the maps, e.g., location of keys and doors. The electricians who are on-call duty update the *filer* when they encounter something they find worthwhile noting. Several electricians have referred to the *filer* as being useful.

A way of sharing how to deal with problems that occur on a regular, but unplanned basis is to tell *stories* of previous problems and their solutions. These stories are told in order to transfer knowledge in the work group. They were told in any place when the work pace was low. Telling these stories was a way of producing, maintaining and communicating knowledge. They also form "traces" of the community's common experience and knowledge that had been built up over time. The stories often have a specific topic, e.g., the following one that is about finding a place.

> A little chat on how much the landscape had changed during over the years leads into a story about "the old days." Roy started telling a story about how he had problems in finding a certain work site in the sixties. This was when a big suburb was being built The story circles around problems of finding a site and that the map was wrong. When driving around in the woods without being able to find the construction site, Roy finds that his car is running out of petrol Just as the car starts to cough, he sees a petrol station downhill and manages to get the car to roll down. When refuelling the car he looks around. And there. he sees the small gap between the trees that lead to the construction site where he is supposed to do his job.

We heard several version of this story. The story is not exactly about diagnosis

and specific problems solving, as discussed by Orr (1991, p. 160). It is an allusion for how to find places. The literal places or situation that story refers to is not of current interest; it is from the sixties! However, some hints may still be useful, e.g., a small road often leads to a construction site and there may be settlements nearby a petrol station.

Another topic for the story telling is how customers may be taken care of. It can for example be frustrating when the customers are not really prepared. Here is an illustrative example:

> We got the place were there was this guy who was stressed up beyond belief, he just could not talk . [laugh] So we helped him out I mean we could not just leave and there is always something we could do I gave Dennis [planner] a call, but he was not answering – I knew he shouldn't but anyway .

It is the planner's job to take care of these situations. However, this is sometimes prohibited by a high workload, and the electricians may have to solve it themselves. They have to negotiate with the customer and come up with a solution. Moreover, the attitude of the stories is to relieve some pressure from the planner (and for the customer too).

4.2 Indexing

One way in which knowledge management takes place in the mobile setting is what could be called "indexing." For example, when people explain to someone else "how to find a particular place," they would typically relate to recognisable physical objects, e.g., "do you remember where we did this and that work two years ago." Whether or not the other party (one or several) knows a particular object becomes obvious in the conversation. For example, "You mean where...?! Yes, I know where it is...," would be a typical example of someone recognising a "sign," while simply being quiet would indicate the opposite.

Let us now consider an example of how people use this kind of knowledge.

> The planner receives a call to his cellular phone (while driving). It's from a construction site where they "want service now " The planner says that he is going to "fix it." Then he hangs up and makes a phone call "Jonsson? . could you go to 'project Hjalmar'? They need 'construction electricity' [preliminary connection used by construction firms] Can you fix it immediately? They know that you're going there. the same place as the last time " He hangs up

The task in question was quite small, and the planner just wanted to get it out of the way. The planner knows that the electricians are away on maintenance work that is not time-critical. Therefore, he could tell the client that the two electricians will show up. The planner also knows that the electricians he calls have been doing work there before, and they know exactly where it is; thus, they are the best-fit work pair at this point.

4.3 Diagnosing

"Diagnosing" is related to "indexing." In "diagnosing" one or more people collaboratively seek to make sense of a situation. One example of is when electricians encounter a cable that is not on the map. If it is not determinable whether or not the voltage is up; the cable has to be "shot," i.e., putting it out of operation forever. This could mean for example that a housing area looses electricity, but it is, of course, better then that someone gets injured. This is, however, a decision that the electricians would collectively take with the planner as a last-way-out-solution.

A more interesting thing is that maps cannot be strictly followed since minor inaccuracies are very common. The following paragraph is an illustrative example of an error in the map is "diagnosed."

> A work pair was going to connect power to new houses. At the site the map did not seem to fit the landscape. Chris and Bernie started turning and shuffling the map back and forward while discussing intensively After a few minutes Chris says that the construction firm may have built an extra lane of houses that we do not to have on the map This turned out to be correct and the work could continue, now with additionally six houses to connect power to

In this case Chris suggested "there is an extra lane of houses," and since Bernie seemed to agree, this was the way in which they made sense of the situation.

One of the reasons maps do not match the landscape is that landscapes change. Moreover, the surveyors and the electricians do not always agree on the updates of the maps, which results in compromises. Confusion may occur, but the electricians can still make sense of the map since they know about these circumstances. Another difficulty is that other companies have equipment in the ground (telecom cables and water pipes). Even if this information is shared among the companies there is always be the risk that the maps differ.

4.4 Foreseeing

"Foreseeing" is using knowledge to make suggestions about the future. Let us consider one example. When the electricians are at a specific place they would typically project beyond the task at hand. For example:

> John says to the civil engineer at when they have finished a job. I can see that you are going to call us later this week to get those poles moved over there... I can call my boss and see if we could do it right away? The civil engineer gladly accepts the offer.

Here, John knows that there will be a need to "get those poles moved over there" in the near future, and for that reason, he could provide the client with a good offer. He uses his knowledge to "foresee" how things will proceed. It is tightly coupled to the circumstances that are unveiled for the electrician at a specific place and the local knowledge of what possible action to take.

4.5 Practical knowledge management: an initial sketch

Based on the empirical observations, we have started to develop a framework of "practical knowledge management." The objective is to join the debate of knowledge management in a constructive way, that is to say make suggestions that may be helpful in practice.

We start by examining the relations between the *sharing mechanisms* and their utilisation. We are fully aware of the fact that these relationships may not be clear-cut. Nevertheless, there seems to be connections between the mapping

- from ephemeral into indexing,
- from persistent into diagnosing, and
- from stories into foreseeing.

One example of how ephemeral sharing maps into indexing is when the re-organisation of personnel relies on the plans of the day as stated at the daily morning meeting. For example, a morning meeting we observed involved a discussion about "how much personal a particular assignment will need." Later during the day, we observed how Chris called Ronnie (the planner), requesting more people.

> Chris "We need more people here. Roy said that they had it slow today Should I call him and ask them to come?" He hands up and calls Roy.

In this situation, Chris explains for Ronnie that Roy had told him previously that he and his peers will not have a very high workload this particular day. When Chris finds out he needs more people, he (seemingly) therefore makes the suggestion (for Ronnie) to call Roy, and in doing so, he explicitly refers to what Roy has told him. Thus, ephemeral sharing was mapped into indexing.

Persistent sharing mechanisms, such as maps and documents, were used for diagnosing. Most often, diagnosing took place in the field where the local conditions of the place could be matched with the records. The *filer* for instance, is an obvious support in some diagnosing processes.

The administrators have got a lot of persistent record at the office. When they are in contact with the electricians it is most often some information at the office that is needed, e.g., customers address or telephone numbers.

Stories contain a more abstract type of knowledge. The stories map into actions of foreseeing and diagnoses. Not only situations, problems and solutions are communicated in the stories, but also opportunities for giving better service.

A system based on these categories could support improvisation and help the electricians to gain an overview of the customer's needs and available resources. It could also be useful in some cases of minor emergencies for on-call duty. Bigger assignments, on the other hand, could still be centrally co-ordinated.

5 Discussion

Knowledge management and *organisational memory* have inspired important debates within CSCW. Often these are contrasted with reference to *local knowledge*. Bringing these perspectives together, we have proposed new categories of "practical knowledge management" that cover the layered abstraction and creative mapping of local knowledge to new places and procedures. Exploring knowledge management in the day to day work of electricians, we found four important ways in which it took place. To summarise:

- Sharing, i.e., the exchange of knowledge between parties.
- Indexing, i.e., one party explains to another what knowledge to retrieve.
- Diagnosing, i.e., two parties make sense of a situation, i.e., how it should be interpreted.
- Foreseeing, i.e., one party (or more) uses knowledge to project the future.

For each of these we would like to compare and contrast some central views of organisational memory and knowledge management literature:

- Making the argumentation explicit

Central to the argumentation of organisational memory is the notion of *rationale,* i.e., that supplying the motivation and structure of the "memory creation process" (Conklin and Begeman 1988; Yakemovic and Conklin 1990). It follows from this focus that an organisational memory system should try to make the *decision processes explicit* by capturing all essential aspects. In a sense, everything relevant should be saved and made available to anyone who might need it.

- Finding and interacting with experts

Another important objective of organisational memory is to support team members in finding and interacting with experts, and to accomplish such work more effectively (Ackerman and McDonald 1996; Karduck 1994).

- Putting knowledge in chunks

In knowledge management, the central objective is often to capture, organise and share the knowledge of employees for the achievement of a common, strategic goal. This objective necessitates breaking up knowledge in manageable chunks of various types, for instance, administrative data, facts and figures about the operations, declarative knowledge, procedural knowledge, and analytic knowledge (Edwards and Mahling 1997).

- The roles of knowledge

In knowledge management it is also suggested that roles should be assigned for assuring relevance, accuracy, and periodically review of material. It is also suggested that various techniques from automated retrieval reasoning are central to this kind of learning organisation.

We will not, in the paper, argue against the central tenets of these two related disciplines. We think, however, that the picture emerging from the following comments may be one on the basis of which some design implications may be

drawn.

5.1 Sharing

In our case, mechanisms were implemented in attempts to persistently share knowledge through artefacts. On the other hand, we also found ephemeral sharing that was generated for a purpose and for dedicated receivers (explicitly seeking it). In this respects our findings are much closely aligned with those of Bannon and Kuutti (1996), Randall *et al.* (1996), and Anderson and Sharrock (1993), who claim that knowledge is actively constructed for the individual in a particular context. We think that the shear volume of relevant information that conceivably could be captured in this case is prohibitive of the former approach.

Organisational memory has to assume that people are willing to be experts for "unknown others," thus taking on additional work by explicating and storing experiences in a common information space. A related assumption is that users of these systems will actually trust that they contain reliable, updated information. We did not observe knowledge explicating and storing activities that were external to work itself, i.e., at least not in a formal way. Thus, the practical use of knowledge as the manipulation of "knowledge chunks" does not agree with our observations. One central design implication would be to avoid redundant work imposed by explicating knowledge creating chunks as well as allowing users to partake in designating experts. The role of experts is one of several roles that were not explicit in the organisation. It seem hard to see what could be gained by forcing the organisation to allocate and manage roles such as "gatekeepers" and "knowledge librarians" (Edwards and Mahling 1997).

5.2 Indexing

In traditional organisational memory, "knowledge" is usually structured by a theory of argumentation. For some aspects of knowledge, in our case, such as rules and formal procedures, this is certainly an appropriate approach. Also, when the solution space may be anticipated, i.e., when and if the problem relate to a specific geographical location only. We found in other instances, that people organise information in an individual and situated fashion. Thus, one design implication could be to allow personal, rather than general mark-up, indexing and organisation of the data captured.

It is often rightly assumed that people could be helped by experts (or rather get assistance) in solving problems. However, knowing who the expert is for the particular problem at hand, does not seem to be a matter of formal roles. We found that people often rely on informal, individual networks in combination with open requests. Knowing who should have been asked may not be known until after the problem is solved. Put simply, *knowing who* is sometimes a major part *knowing what.*

The ways in which we observed people collaboratively indexing knowledge, imply that it is a complex phenomenon, which is related to action rather than representation, and thus, cannot easily be broken down into general chunks. This also shows that all members of an organisation could serve as "experts," "gatekeepers," "knowledge librarians," etc., depending on the situation.

5.3 Diagnosing

Many organisational memory systems, such as Answer Garden, require that the requesters of knowledge know, in advance, how to formulate a question. This is often possible when the problem space is limited, for instance when it is (yet) an instance of a problem with new parameters (call the janitor first – what is the telephone number?). We found, however, that in many instances this is undertaken as a collaborative task, during which the problem-solving process is already ongoing. It is a known phenomenon in information retrieval that to express an interest in a formulised query is difficult (see, Marchionini 1995). This could mean that the organisational memory system should not be conceived separately from the task-support for these users. As Anderson and Sharrock (1993, p. 149) puts it: "patterns of knowledge and patterns of action define each other." These ideas are not so far from the work on "living design" (Terveen *et al.* 1993) and social activity indicators (Ackerman and Starr 1995).

Diagnosing was a truly collaborative effort that seldom was preceded by one person explicitly trying to find and interact with an expert. It would be necessary to engage assistance in implementing and evaluating solutions as well as giving advice on a more abstract level.

5.4 Foreseeing

Traditionally, organisational memory has been concerned with the past. The majority of requests documented in our case similarly tries to resolve a current problem using previous experiences. We also found, however, some instances of future projections and business planning on the basis of situated problem solving. This could means that knowledge management should be seen in connection with a relaxed workflow design. Foreseeing is about creating possibilities for action and thus making a business opportunity for the people present in the situation. Thus, it is not always necessary to find experts that fit the "problem," but rather to define a problem that may be solved by the experts that are already engaged.

6 Conclusion

This paper adds to the existing body of empirical work in CSCW by dealing with a novel class of work, namely mobile service work. Our empirical results provide

a sound grounding for further design and evaluation of distributed support for practical knowledge management in a mobile setting. The analysis challenges some conceptual underpinnings of work in both sides, but, at the same time, this critique opens windows of opportunities for implementers of CSCW systems in what seems to be, for researchers and consultants alike, a very compelling domain.

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