

Local Expertise at an Emergency Call Centre

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Abstract. Some important research has been undertaken in recent years on knowledge management within the CSCW community, drawing attention to the inherently social properties of knowledge and how it is shared. Much of this work has demonstrated the complex and sophisticated needs of so-called knowledge workers, and the requirement for better understandings of knowledge sharing processes. The example we present in this paper is that of knowledge work in emergency calls at SOS Alarm in Sweden, currently of interest because of a planned new system that will allow for centre-to-centre case coordination and not only within the centre. What makes such a case interesting is that workers in this context face an unlimited variety of incidents that require interpretation, decision and coordination, many of which require the deployment of local knowledge and, as importantly, have to be dealt with in a timely fashion. In this paper we focus on how a number of people work to combine their knowledge and expertise in a time effective way.

Introduction: Knowledge Management and Sharing Expertise

The argument we present in this paper concerns approaches to ‘knowledge management’ or ‘shared expertise’ and its relevance to safety and time-critical domains. The case we examine below is taken from a wider project (Helgeson et

al, 2000, Normark, 2002a, Normark 2002b, Pettersson et al, 2002) dealing with Swedish emergency call centres. It deals with the way in which current arrangements rely on a local organization of knowledge and how this might be affected by the development of a new system that will support case coordination between the 20 existing centres instead of the current local case handling.

In principle, the development of new information and communication technology allows for the sharing and management of information virtually anywhere at anytime. Along with these technological affordances, however, has come the recognition that new technology must be accompanied by appropriate approaches to the problem of what is variously termed information, expertise or knowledge. Terms such as 'knowledge' and 'expertise' are not, and arguably cannot be, precisely defined for they range over some quite heterogeneous acts. Nevertheless, something of an opposition has developed, one in which 'expertise sharing' has developed as an alternative to 'knowledge management' (KM). That is, KM might be seen as an approach which stresses knowledge as data or information, and thus sees the attendant problems as being to do with structure and codification. The alternative has been a 'social' perspective. We would suggest there are two closely related elements in this alternative. Firstly, the emphasis on the 'social' has produced attention to the active ways in which knowledge is acquired, maintained, shared and 'passed on' and secondly, this has been accompanied by new methodological recommendations.

A specific contribution of CSCW to this field, then, has been firstly to emphasise the 'social' quality of expertise and thus how some of the more 'information theoretic' assumptions of knowledge management- broadly, the assumption that problems of knowledge are principally to do with encapsulating its structures and finding efficient ways to transmit it- do not adequately encompass the contextual character of its use. Researchers in the CSCW community, then, have taken a distinctive view of knowledge as being in part non-propositional; as residing in 'practices', and hence as being 'tacit' or 'local'. Critical reflections on both Organizational Memory and Knowledge Management have led to a re-thinking of these issues (see for instance Randall et al, 1996; Ackermann and Halvorsen, 1998; Ackermann et al, 2003; Groth and Bowers, 2001). Recently this critical stance has led to analysis and treatment of themes such as the organizational conditions which affect knowledge or expertise sharing in the local setting. This might involve attention to the conditions which limit it; to the technologies which might support sharing, and attention to the knowledge areas that might be shared. Ackermann et al stress that examinations of knowledge problems (and solutions) in and for the organization should be conceptualized as examinations of 'expertise sharing' in order to provide for the kinds of nuance and complexity that characterise real acts of expertise sharing and thus are likely to inform genuinely usable technologies under this rubric. Various broadly ethnographic contributions to this book show how, in a range of contexts, the

activities of organizational members orient towards accessing the expertise of others in some complex and subtle ways. We find this approach very promising for CSCW. It is a route along which we might continue the process of moving beyond some sometimes narrowly defined interactional and technical problems of technologically mediated communication towards a more fruitful engagement with technology and the organization.

One approach, and it is the one we adopt, to dealing with this has been to characterise certain kinds of knowledge or expertise sharing as 'local'. This refers to the way in which some forms of knowledge have a relevance only in local circumstances and often remain invisible to the 'global' organizational view. It is therefore a subset of the more general category, 'expertise sharing'. Thus and for instance, what Randall et al (1996) have termed the 'Mavis' phenomenon, which refers to the way in which knowledge in an organization is socially distributed, turns out to be a significant aspect of organizational effectiveness (and not necessarily in ways predicted by organizational charts). Similarly, Harper et al (2000), have emphasised how knowledge of procedures, others' expertise, and of customer requirements are all locally deployed. One significant aspect of this is the idea of 'knowing who knows' (Groth, 2004).

Methodologically, these themes pan out into a search for adequate knowledge elicitation techniques that allow us to determine what knowledge is held and by whom, who else might need to acquire and use it, and how it is to be made available. In other words, getting beyond narrow conceptualizations of what the expertise in question might be requires an attention to the details of its use. The recognition that not all of the knowledge in question is explicit and propositional (and thus not straightforwardly codifiable) led to substantial use of concepts like 'tacit' knowledge, drawing on the work of Polyani (1967). The problem of uncovering this kind of knowledge has led to methodological reflections which have in turn stimulated a more 'ethnographically informed' approach. This has been evident more than anywhere else in the CSCW arena, where the problems of maintaining knowledge bases in contexts where personnel change; where knowledge is geographically and organizationally distributed, and where it might be difficult to ascertain what the relevant knowledge in question might be have informed a more sophisticated view.

A number of issues are related to the view of knowledge as socially distributed. They include, for instance, understanding of what knowledge might be; how knowledge is shared; what organizational and social obstacles might exist; the importance of 'local experts' and 'knowing who' (Randall et al, 1996), networks, trust and bias discounting (Strauss, 1993), and what appropriate technology for sharing expertise might look like. Fitzpatrick gives us a good example of the sophistication and nuance provided by such an approach (Fitzpatrick, 2003). She shows us, for instance, that while some knowledge sharing activities are explicit, putting the content to work most effectively was, in her example, critically

dependent on knowing relevant context information. Having a good network of contacts was also critical to getting the work done. (ibid: 81-82) She goes on to distinguish between (generally codifiable) information 'in the large' and information 'in the small'. The latter case is where, *'much of the sharing is ... only triggered in the context of interpersonal relationships and only makes sense when interconnected and put to work with preexisting knowledge.'* (p82). It further involves 'finding-out' practices such as, *'finding out information in the large, finding out information in the small, finding out what people do now, and finding out what people are like.'* (p83). Information 'in the small', we would suggest, is more or less what we refer to in our use of the term, 'local knowledge'. We want to draw on this work in order to make comparisons with local knowledge work in another context. We do so not only because attention to aspects of 'information in the small' remains rare but also because Fitzpatrick describes her case precisely in terms of features such as being driven by 'ad hoc, unpredictable, event-driven demands' and the fact that the work is therefore to some extent time-critical. She further refers to information gathering as involving various strategies, two of which are 'just-in-time' and 'just-in-case' (p87). Such an approach we believe to be invaluable because it acts as a reminder that information gathering and sharing work is *occasioned*.

There is a need for more case studies with which to understand the varied ways in which local knowledge work might be complex, and understanding why this might be so. Significantly, in the organizational context we describe, the problem of expertise sharing is highlighted by the fact of a 'working' division of labour (Anderson et al, 1989). Here, expertise is shared among operators affected by local and time-critical problems, and engaged in achieving common goals, but undertaking different tasks in different places. We will argue that the means by which outcomes are successfully managed is a product of the relevant management of local knowledges by various parties.

Emergency Call Centre Work

Studies of 'centres of coordination' (Suchman, 1993) such as those of Hughes, et al (1991) and Heath and Luff (1991) identified features of control rooms pointing to the elegance of coordination solutions such that information could be obtained and acted upon 'at a glance' in and through the use of some quite mundane artefacts. Other research has similarly identified how artefacts in control rooms may be used to furnish solutions, prompt mutual awareness, and act as a locus for coordinated activity (see Goodwin and Goodwin, 1993, Watts et al, 1996). Similarly, work on emergency services emphasises the role of call-taking (Whalen, 1995), the cooperative nature of dispatch (see Martin and Bowers, 1999), 'talking to the room' (Artman and Waern, 1999) and the importance of redundancy and visibility (Tjora, 2004). In turn, Pettersson et al attempt to draw

generic features of this work from the above studies and from their own observations of SOS Alarm (Pettersson et al , 2002). Other work shows how the successful emergency operator coordination not only consists of case decisions but also the reasoning that leads to the decisions (Normark, 2002).

As we have suggested, emergency services work suggests an interesting test case for knowledge management or expertise sharing issues. This is precisely because emergency service work, like other similar contexts (see e.g. Berndtsson and Normark, 1999) is time- and safety- critical. Proposed solutions for new organizational forms, then, must maintain these fundamental purposes. They must be more or less error-free, timely and comprehensive. A relevant assumption is that 'local' knowledges of a varied and sometimes subtle nature constitute one of the ways in which this work is currently achieved. If these knowledges are likely to be attenuated under the move to more global arrangements, then there is a *prima facie* case for analysis of their possible significance, especially as current solutions to time- and safety criticality are 'at a glance'. That feature, we suggest, makes some forms of expertise sharing in electronic form particularly problematic.

If our assumption above is correct, then it would suggest that some real attention needs to be paid to the nature, extent and frequency of local knowledge in use. The tricky problem for knowledge management in this context is that a range of different knowledges need to be encapsulated in such a way that accurate results can be delivered quickly and reliably to those who need to use it, precisely because the system is both time- and safety- critical. This leads us below to examine the character of practices, solutions, adjustments and knowledge in local settings. Not for the first time, ethnographic approaches to the study of expertise or knowledge management/sharing might reveal features of the expertise/knowledge in question that might otherwise be overlooked. As Pettersson et al (ibid) point out, operators here work in the context of a range of ambiguities. Their training, knowledge and experience are critical. We consider our emergency call centre case relevant for understanding what the limits of viewing knowledge as generically *shared* might be. In other words, two conditions restrict the degree to which knowledge or expertise 'in the large' constitutes a solution to a knowledge management problem. Firstly, the particular set of work conditions in this instance are *highly* constrained by time considerations. Secondly, the planned organisational changes (which have to do with the reduction in cost entailed in providing for a range of centralized functions in distributed, and hitherto local, environments) involves increasing geographical remoteness from the location of incidents. If, as we state, a central feature of emergency services work as done today is that it relies on a set of local knowledges which are socially distributed both within and between different operational centres within a region, then it seems likely that globalised functions will be predicated on some sharing of expertise across more remote centres. What is particularly interesting for our

purposes is the comparison between Fitzpatrick's (ibid) context and what we find at SOS Alarm. One difference is that creating 'a good network of contacts' is not currently so relevant, but might become necessary under the new arrangements. A similarity is that knowledge 'in the small' is most certainly triggered by events in exactly the way she describes.

Emergency Case Handling

SOS Alarm is the company (state-owned) responsible for managing telephone calls made to the emergency telephone number (112 in Sweden). SOS operators receive, categorize, document, dispatch and monitor the incoming cases. At larger SOS centres, a case is almost always coordinated between two operators, a call-taker and a dispatcher. The centres are equipped with computerized maps, maps made of paper, folders and a Computer Aided Dispatch system with a local database called CoordCom. SOS Alarm is (at the time of writing) developing a new computer system aimed at supporting the handling of different kinds of calls across the centres. In effect, this means standardising the technology use across all the 20 centres and at far as possible standardising work practices. Currently, collaboration between call-taker and dispatcher is entirely local. The new system, however, will allow for the emergency calls to be handled by any centre, e.g. the least busy one, though dispatch will remain within the local centre. In these circumstances, the distribution of knowledge now and in the future would seem to be a critical issue.

Our study was initiated by the SOS Alarm as a part of their development project and lasted about one year, involving not only observations in the Malmö centre but also visits to several of the other 20 centres in Sweden and other similar services (the police call centre in Malmö and bridge control at the Øresund Bridge). The purpose was to study collaboration and technology use in the current setting and suggest ideas for the future centre-to-centre setting. We participated in a reference group that met several times in order to discuss and prepare materials for the procurement process. The new system, which currently is under development, is large (estimated project cost ~10 000 000 Euro) and will not only cover national emergency service, but also commercial services such as the reception of automatic elevator alarms. We had an ethnographic approach in our studies with focus on collaboration in between operators and did about 15 observations of 1-2 days at a time. During the observations we did a few video recordings but mostly took notes because of the sensitive medical information that is exchanged in emergency dispatch service. Every video recording had to be stored and transcribed in the centres based on our secrecy agreement; otherwise we had full access to the centres. The child birth case presented in this paper is one such recorded case. This case is also analysed based on SOS Alarm's own audio tapes that we got access to.

We can trace the logic of information-handling at SOS Alarm from the moment a call is received at an SOS centre. For the call-taker, the first issue to be dealt with is whether the call is an appropriate emergency case to deal with at all (bearing in mind the large number of hoax calls made, and other forms of time wasting), followed immediately by a decision concerning the priority to be attached to the call (based on how serious the case is, and how immediate the response needs to be. Priority is allocated on a 1-4 scale.). Following on from this, decisions have to be made concerning the relevance of incoming and outgoing information, and in particular who needs to hear it and possibly act on it. This work is done while documenting and recording information and decisions in the CoordCom system. Operators often have medical knowledge, unsurprising given that many call receivers and dispatchers are ex-nurses and ambulance drivers. Other information that is recorded in the system will include the “where” and “who”; the address of the incident and who the ambulance should pick up.

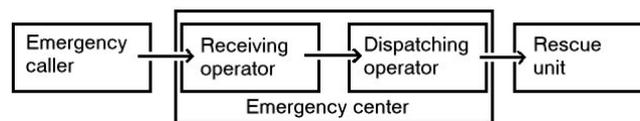


Figure 1. A general overview of the communication in an emergency case

As soon as some basic information is uploaded in the CoordCom database, the ambulance dispatcher can start dispatching (if it is a priority 1 case) while the receiving operator can continue to collect more information about driving directions, development of the accident, etc from the caller. S/he chooses among the resources that are suggested by CoordCom, based on proximity to the ambulance station and a set of other conditions. After calling the ambulance verbally on the radio, the operator sends out a mobitex message, a text message that gets printed out in the ambulance, containing the case information that was entered into CoordCom. The mobitex system is also used to send automatic status reports from the paramedics to the dispatcher. The dispatching operator then follows the progress of the ambulance or rescue vehicle through these status reports. S/he may also help coordinate information between different vehicles.

Local knowledge in use: The Childbirth Case

The case we describe is dealt with at the Malmö centre. ¹The Malmö centre covers the whole south part of Sweden (Skåne).

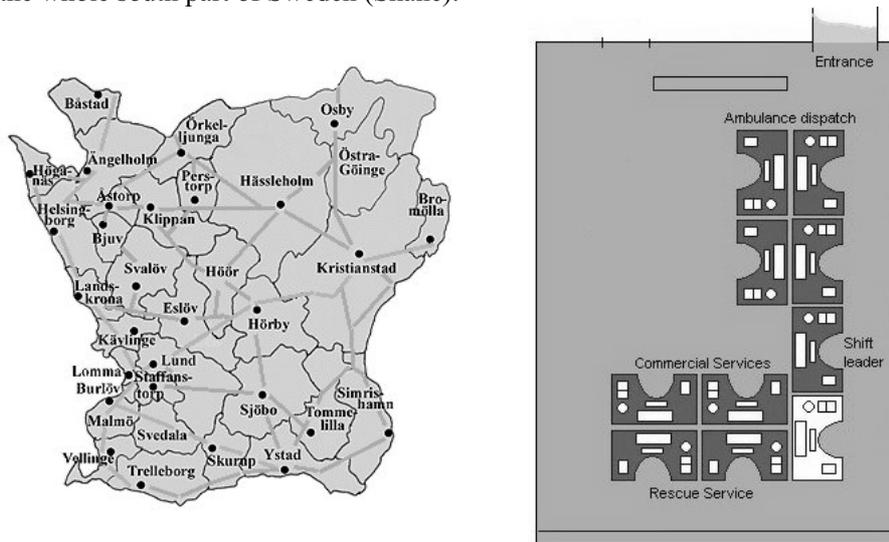


Figure 2. The Skåne region and the position of the tables at Malmö SOS center

Much of what we have described above of the database handling done by operators could be described as information-sharing ‘in the large’ insofar as it involves the use of standardized methods and technologies to allocate known resources to deal with identified events. We wish to show using one extensive case how information and expertises ‘in the small’- knowledges that we will refer to as ‘local’ knowledge- are shared as well.² Knowledges and expertises of this kind are, however, characterized by two factors. Firstly, expertise in this context is geographically distributed across a number of different actors in the case and, secondly, the relevant use of knowledge and expertise is occasioned by, and arrived at through, the need for collaborative work to resolve problems. Again, one of the powerful factors driving this collaborative work is that the actors in the case do not know at the outset what the relevant forms of useful knowledge and expertise might be, nor do they know who might be in possession of them.

We have selected a quite mundane and everyday (although potentially life-threatening) case of a woman about to give birth to her baby to illustrate our themes. A crucial character of the work of receiving and handling emergency

¹ In Malmö the GPS system in the ambulances is fully implemented, i.e. operators can follow the movements of the ambulances on the map computer.

² There is always a trade-off between detail and coverage in empirical reporting. We opt for detail here, but readers should be aware that we saw many such cases.

cases, as stated, is that it needs to be done *fast* and with trustworthy technology. Local knowledge is therefore decisive in many situations in order for the operators to be able to grasp incoming information and to know what to do with it. In the analysis of the Childbirth case, we identify what situations engender the use of local knowledge, and thus what kind of information would be lacking if the operators were to be sitting in different rooms and not working with their own geographical area. An overview of the verbal exchanges between the participants in this case looks like this (the direction of the arrows show who contacted whom):

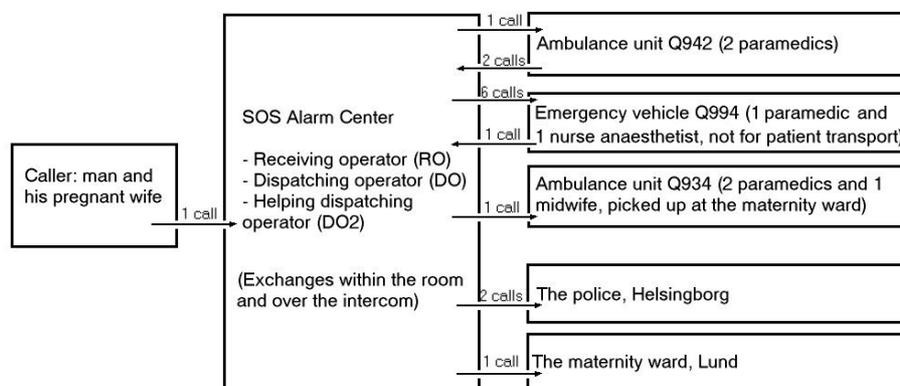


Figure 3. An overall picture of the parties and the number of conversations between them

15 calls in total are recorded during the course of this case. Talk in the room is not included. Text messages exchanged with ambulance units (so-called mobitex messages), including status reports that ambulance units send in as soon as they are dispatched, at the site, on their way to the hospital, and so on, are also not included. (This was because of limitations on our ability to record everything simultaneously and the existence of certain confidentiality issues.) As the overview shows, there are several different people involved in this case, and we count 14.

Call from Help Seeker to RO (Receiving Operator)

The ethnographer was sitting next to the dispatcher who would turn out to be responsible for the ambulance area in question (we were also able, later, to review the system recordings of the case.) The operator firstly receives a co-listening request from the receiving operator. A man, apparently the husband of the pregnant woman, initiates the call. The dispatcher receives the listening-in

request after the need for an ambulance was established, and the tapes reveal that first interchange³:

4 Husband (HS): Yeah, hi, can you send an ambulance?

5 Receiving operator (RO): What has happened?

6 HS: She's very pregnant you see the waters have broken, you see and she's bleeding everywhere

The wife of the caller is, it turns out, one week overdue in her pregnancy and her waters have broken. Her cries can be heard in the background and the receiving operator tries to calm down the situation by telling the husband that this is a natural occurrence when the baby is about to be born. The husband at this point asks the operator to talk to his wife directly. The operator tries to soothe the woman while the woman attempts to explain what is happening:

30 RO: Are there large blood lumps coming?... yes, I'm sending for an ambulance at once...so ... it is on its way to you now ...

31 Wife (AB): [crying loudly]

32 RO: ...so, so, try to calm down now

33: Dispatching Operator (DO): I'm with you [only heard by the RO through the listen-in function]

34: RO: OK...you know the baby is supposed to come out now [said to AB]

When the caller indicates that his wife is bleeding heavily, the operator immediately reacts. She requests co-listening by the ambulance dispatcher (DO) through the CoordCom system. When the dispatcher answered the co-listening request, she says, "I'm with you", as is customary, and indicating attentiveness. Otherwise the dispatcher only listens. While the conversation is going on, both the receiving operator and the dispatcher have the case file on their screens. We should note here that the RO can see the DO who is sitting about 5 meters away and they can maintain eye contact.

Talking with Emergency Unit Q994

When the emergency call is finished, the receiving operator enters information into CoordCom and while doing that the two operators discuss matters through the still open co-listening connection. They agree that it is a priority 1 (serious) case and that they should send both an ambulance (Q942) and an emergency unit (Q994-which contains an anaesthetic nurse) as is customary with priority 1 cases at this centre. At this point, the dispatcher selects the units that will get this assignment. She contacts them through radio and sends mobitex messages to them, providing both an event code and also the information, "large lumps of

³ These conversations were translated from Swedish

blood coming out". Since Helsingborg has the closest emergency hospital/maternity ward, it is put as the destination for the dispatch. Again, this simple action relies on a close knowledge of the local geography. Bearing in mind that relatively small towns are involved in this case, the dispatcher needs to quickly identify the nearest hospital. She does so in this instance without recourse to any map-based information, because in effect she knows the local hospitals by heart, which of them are the emergency hospitals, and their relevant codes.

Having been contacted and informed as to the nature of the problem via radio and mobitex, the 'anaesthetic' nurse, who is a member of the emergency ambulance team, decides that a midwife should be sent to meet them on their way to the hospital. The ambulance then calls the dispatcher. The following is an excerpt of a radio call from the emergency unit Q994:

64 Q994: Can you fix us a midwife from HBG, over [HBG= short for Helsingborg]

65 Dispatching Operator: I can do that if you'd like, sh...

66 Q994: Yup, my nurse anaesthetist .. kind of thinks so.

67 DO: The nurse anaesthetist thinks that I should get a midwife?

68 Q994: Yes, please

69 DO: I'll solve it, will you go and get her?

70 Q994: Nah, we don't really want to go to Helsingborg and get her, really...

71 DO: No, it's Helsingborg, yes, all right, sorry, we'll solve it

The pregnant woman lives in a small town, Landskrona. Helsingborg is about 200 km north of Landskrona and it is possible that the patient is in need of immediate emergency care. In order to get the midwife from Helsingborg to Landskrona, the dispatcher needs a fast vehicle, but at this point has no ambulance available. The operator misunderstands the paramedic, assuming that he is already close to the hospital. The paramedic uses the short hand expression HBG, he works in that area and perhaps it is a more obvious expression for him than for the operator, who is located in another city in the area. By using the map computer, the operator is able to see where the ambulances in the area are approximately. She judges that there are not enough available ambulances in the area if another ambulance is dispatched. The rule is that no one should have to wait more than 15 minutes for an ambulance so an area cannot be emptied of emergency units. The operator then decides to ask the police in order to get a unit that can transport the midwife from the maternity ward in Helsingborg to the ambulance containing the pregnant woman. The dispatching operator then gets help from another operator, DO2, who contacts the police (obtaining the number from the CoordCom system) while the DO contacts the maternity ward in Helsingborg. She calls the police in Helsingborg:

96 DO2: Hi, you don't have a...um...patrol available? Possibly?

97Police (Po): Possibly? Well, yes,maybe...

98 DO2: Well you see, we might need a midwife from Helsingborg to Landskrona quick as hell ... maybe!

99 Po: A midwife from Helsingborg?

100 DO2: Yes

101 Po: Towards..um..Landskrona

102 DO2: Landskrona...but it's not...it's not a done deal yet...

103 Po: It isn't...uhu

104 DO2: So we'll get back to you within a minute or two

105 Po: I can put someone on the road for now then

At this stage, it is not yet certain that a midwife is needed, since the ambulance and emergency car have not yet arrived at the woman's house. The receiving police officer promises to have a car ready by the hospital.

2nd Call from the Ambulance Q942

While the dispatcher is talking to the police, the ambulance arrives at the scene and discovers that the pregnant woman has been seeing a doctor in Lund, which is a town south of Landskrona. The ambulance personnel therefore decide to take her to Lund:

119 Q942: This midwife, you know

120 DO: Yes

121 Q942: She should be brought from Lund instead, because she is going to Lund, this one [the patient/mother]

122 DO: Okey dokey, but otherwise we have a police patrol at...um...the maternity ward in Helsingborg just waiting to bring one ...

Here we see new and relevant knowledge, which we will term biographical knowledge, being introduced from the ambulance driver. This emergent information has a clear impact on the subsequent decision to re-allocate the midwife role elsewhere. Given the fact that the ambulance is now on its way to the hospital in Lund, the driver contacts the dispatcher with a suggestion. It now makes sense if a midwife is brought from Lund to aid the patient, because the ambulance is heading in that direction and it will take less time for the midwife to meet up with it, the DO2 then calls the maternity ward in Lund instead:

138 DO2: We need to have a midwife that goes to Landskrona in a hurry and helps an ambulance that's on its way down

139 MW: Uhu, you do

140 DO2: Yes

141 MW: Well, then I'll send it...are you picking her up...?

142 DO2: Yes, an ambulance will come and pick her up

Here, DO2 contacts a new ambulance (Q934) in the Lund area in order to pick up the midwife at the hospital and meet the ambulance coming from Landskrona with the woman. DO2 calls the maternity ward in Lund and has it confirmed that a midwife is available, and an ambulance from the Lund area is sent to pick her up. Subsequently, we hear the following segment of conversation:

Call from the Q934 Ambulance (with the midwife)

159 Q934: They're at the motorway, then?

160 DO: Yes, they're at the motorway, you'll have to meet up with them there

167 Q934: Yes, but you don't know whether this is her first child or not? [the midwife wants to know]

168 DO: No, I don't know ... but we do have both an emergency unit and an ambulance unit there right now and so they will be going down ... Q942 and 994. Did you get the strip, or not? [the strip= the mobitex message that is printed in the ambulance with the main case information]

169 Q934: Yes we've got it

170 DO: Yeah, great

171 Q934: Hey, can we do it like this, that when you see that they have loaded...[the patient in the ambulance]

172 DO: Yes

173 Q934: ...can't you give us a ring so that we can hook up with them [that is, connect the two of them by radio]

By now, the midwife has been picked up by a 3rd unit (Q934). She asks the DO, through the paramedics, if this is the woman's first child, but no answer is forthcoming from the dispatcher. The DO then gives driving instructions to the paramedics, and then connects the two ambulances' radios so that they could talk to each other. While doing that, she also listens to the conversation. The DO then cancels the police unit and contacted the maternity ward at the hospital in Lund instead of Helsingborg in order to get a midwife (MW) that can be sent to the incoming ambulance. The plans work out and the units subsequently meet on the motorway and proceed to the hospital.

Various aspects of the case can be seen as germane to the problem of understanding and codifying knowledge or expertise here. Firstly, the knowledge deployed in this case is of various kinds, including specific knowledge concerning not only the geography of the area and the availability of resources but also biographical knowledge which becomes relevant as the case evolves. Secondly, the knowledge in question is not held by any single actor but is socially distributed. In this case, the emergence of relevant and timely knowledge is a feature of actors including the husband of the pregnant woman, the pregnant woman herself, the operator, the ambulance driver and the paramedic, the police,

the nurse anaesthetist in the ambulance and the midwife who is eventually summoned. Thirdly, and as we shall argue below, what is particularly critical here is the way that what constitutes relevant knowledge cannot be identified at the outset but is emergent.

Combining Local Knowledge

We have deliberately limited our own investigation into relevant knowledge and expertise to a single case, precisely because even then we find that knowledge still takes a variety of forms and remains stubbornly resistant to codification. The importance of wall maps and computerised maps has been discussed elsewhere (Martin and Bowers, 1997; Pettersson et al, 2002), and here our observations lead us to distinguish between the factual information operators might deploy, and which is available in these maps, and *relevant* knowledge which is not. As suggested above, we think that our notion of relevant local knowledge here is akin to Fitzpatrick's 'knowledge in the small'. The various cases we discuss demonstrate the highly contingent nature of knowledge about location- so contingent that it is not easily provided in any hierarchical form. This knowledge, we stress, comes not only from professional experience, but also from the fact that the operators *live* in their area and know the community. Knowledge of matters such as the pattern of traffic jams, the shopping malls, the road works, the popular beaches, etc. comes from the fact that they have to some extent seen and experienced them directly.

Two relevant matters when dealing with the problem of expertise sharing in a time- and safety- critical environment seem especially salient. Firstly, various 'types' of local knowledge may be deployed at one time or another and secondly the relevance of these knowledges can be emergent.

Types of 'Local' Knowledge

In our SOS research, there are at least four different and very broad kinds of knowledge that are visible in local centre work but not currently accessible in any technology. These are:

Knowledge of the local geography and community. This includes local geographical features; weather patterns; the characteristics of buildings, as well as the different ways in which roads and landmarks might be described. It should be obvious that all local operators are, at least after some time, likely to know the names of geographical areas and the main streets to be found within them through accrued experience. But they also know something about local patterns and nicknames, etc, because they live in the community as well. This might be more important than it seems in that when callers introduce topics related to location,

they often do so in vague ways. Thus and for instance, we saw in a further instance an operator in Växjö centre receiving a 112 call meant for the Malmö centre (currently, phone calls may be received at another centre but they cannot deal with it directly and must re-route it to the appropriate centre). The caller in this case says that his friend has fainted and fallen down (hence a likely priority 1 case) "in a park here in Malmö". When the operator asks which park, the response is: "You know, the one in Malmö where they play petanque." Given that she is working in a different area, the operator has no idea where this might be and has to rely on the assumption that this kind of information will make sense to dispatchers and paramedics in Malmö. This kind of local knowledge is, of course, a very difficult type of information to disseminate simply because of its vagueness, but easy to resolve locally, hence:

Op1 (calling out in the room): Anna, you live in Södertälje, do you know if the Södergatan is close to the water?

Op2: Yes it is.

Operators, especially in urban areas, try to pinpoint the exact location by asking callers to give descriptions precisely, but failing this they rely on knowledge of where their colleagues live and may ask them. *Operators thus also act as local experts on their immediate living area.*

Knowledge of local context. The child birth case we describe above suggests knowledge of local context in two ways. It shows the relevance of biographical knowledge as it emerges, and knowledge about the distribution of medical expertise (where it is to be found, and how quickly). As we have demonstrated, important knowledge on which to base decisions about how to proceed comes from different sources including, in this case, the patient herself. There may be other kinds of knowledge of 'local context' that turn out to be relevant in other cases. They might include, knowledge of cultural differences between centres; of local dialects, and knowing the work 'style' of others (which in turn includes variations in tool use).

Knowledge of the 'rhythms of the city', temporal knowledge. That is, demonstrating awareness of what is going on currently in the area one works in, such as large festivals, road constructions, 'rush hour' patterns, etc It includes, for instance, knowledge in connection with time, or what we might call the 'rhythms of the city'. Thus and for instance, knowledge of traffic flows at rush hour, temporary circumstances such as traffic diversions or road works, and occurrences such as sporting events or other large meetings which might substantially affect traffic flow. Again, this kind of knowledge is often immediately available in virtue of operators' living arrangements.

The local variations we are able to identify are more or less taken for granted by operators, embedded as they are in the business of 'dealing with this case', and thus seldom remarked upon. It is, in consequence, difficult to pinpoint exactly what knowledges are displayed and who has them. We are certainly not confident

that we have been able to describe all of the different knowledges that might prove relevant to a case, although we can state with confidence that the kinds of issue we mention here crop up more or less regularly.

Emergent Properties and Social Distribution of Knowledge

The second problem is that of the emergent properties of knowledge. The case we detail suggests that relevant knowledge is constructed at various different stages in the case, depending on how actors construe what is going on. 'Expertise combining' in this sense is a matter of actors contributing relevant knowledges at relevant times, in accordance with problems that arise and solutions that might be proposed. 'Knowledge' or 'expertise' in this context can refer to judgements concerning whether they need to introduce other actors to unfolding events. Thus and for instance, at the point of the initial call, the operator's problem is how to judge the severity of a case where the pregnant patient is 'bleeding everywhere ..' and to ensure that the necessary expertise will be present in a timely fashion by dispatching an emergency unit with a nurse/anaesthetist. The decision by that nurse upon arrival that a midwife will be required to accompany the patient to the nearest emergency hospital (some 200 km away) is an example of the same thing.

As the case unfolds, decisions need to be made about where that midwife is to be obtained from and how to get her to the ambulance. The first decision is to bring her from Helsingborg, where the maternity ward is located, in order to meet the emergency unit on the road. From here on, we see the emergence of a possible solution to the problem of the midwife, and subsequently a change of mind. Initially, the ambulance driver has to correct the operator's error in believing that the ambulance itself can pick up the midwife (the midwife is to come from Helsingborg, which is the destination of the emergency unit. Precisely the point is that the midwife should accompany the emergency unit to the destination). The operator establishes that there are insufficient units available and makes the decision to involve the Helsingborg police in the transportation of the midwife. All of this, it should be remembered, takes place before the ambulance and emergency unit arrive at the pregnant woman's home.

For this reason, the operator makes an arrangement with the police at Helsingborg (lines 102-105) whereby a car is made ready but not yet sent on its way. At this point, when the units arrive at the patient's home, new knowledge becomes available to the crew (lines 119-122). It seems that the patient has been seeing a doctor from another town (Lund) and thus the appropriate action is to take her to the hospital in this town. This means that the midwife should also be obtained from the same town so as to be able to meet the ambulance and emergency unit en route. An ambulance from the Lund area can now be made available to deliver the midwife to a meeting point (lines 138-142).

The ambulance carrying the midwife still has to rendezvous with the unit carrying the patient, and the next piece of data involves an exchange concerning where they are likely to meet up- it being the case that the operator is tracking both units (lines 159-174). At the same time, other requests for medical information are transmitted and the suggestion is made that it would be better if the two units are 'hooked up' for direct radio communication (170-174). Only at this point does the operator cancel the police unit from Helsingborg. Evident from our rehearsal of this case is the fact that relevant knowledge is not held by one person alone, nor can the relevant competence be presumed to be present in any individual's hands. Different actors at different times bring relevant knowledge and expertise to the table, combining them to find appropriate solutions.

Conclusions

As many studies have shown, 'elegant' or 'seamless' practices are easy to find in face-to-face work but not so easy to produce in distributed settings. When we factor knowledge and expertise into this, the degree of geographical separation- not just the fact of- makes a difference. We have tried to support and extend the argument of Fitzpatrick and others concerning the analysis of 'shared expertise' by establishing a limiting case. In our one extended case, certain background features define and limit the properties of expertise sharing in this environment. They are firstly that knowledge must be accessed relevantly, quickly and accurately. Of course, this is directly related to what kind of knowledge will turn out to be relevant. Secondly, that in some instances and regardless of the fact that cases are given different priorities at the outset, knowledge relevance is constructed by *ongoing* determinations of the urgency or seriousness of cases. Thirdly, that knowledge is socially distributed. It is not typically held by one expert and by one expert alone, nor can one assume equal levels and types of expertise across all parties to the encounter. This has particular ramifications when, as we see, some of the knowledge which becomes available is provided by mobile agents like ambulance drivers, or when particular medical expertise is required.

It is unlikely, in this context, that any near-future technology can encapsulate all knowledge in this domain, encode and structure it, and make it available to all operators. The case we deal with illustrates why. The relevance of knowledge depends on the emergent properties of situations; the socially distributed nature of expertise; and the need for it to be obtained in timely ways. It is thus not only the obtaining of knowledge that is of interest but the *organised properties* of knowledge seeking behaviour and how responses are adjusted (in accordance with how knowledge is offered) that are important. Compared to Fitzpatrick's (op cit) examples of acquiring knowledge in the small - how people in the office environment find out what people do know through browsing printers and

noticing unexpected books at other people's desks - the SOS operators have to find out what people know during a time critical activity and thus in situ. This is what we label *expertise combining*. Expertise combining *within the SOS Emergency Centre is the organised work of several people, often in different locations and some of whom might be mobile, seeking and offering relevant knowledge in a suitable and convenient form that meets time-critical conditions*. The main reason for this, we argue, is that what constitutes relevant and useful knowledge is *emergent and cannot be easily identified or structured in advance of the particular case that arises*.

The obvious consequence of our deliberations is a 'categorical' problem. By this we mean that, even if we emphasise the problem of replicating local knowledges in one specific set of cases - relating to geographical location - there still appear to be many ways in which such cases might be categorised and embedded in systems. Appropriate categorisations may depend on the way in which any given case unfolds, and relevant knowledge has to be available in such a way that all actors have more or less immediate access to it. It should be apparent that at present the operator acts as a conduit for the dissemination of relevant knowledge and expertise, utilizing information from available technology such as map computers and some geographical and medical knowledge (and also on the basis of her knowledge of the limits of her own expertise). At the same time s/he is receiving, based on expertises and knowledge held by others, relevant information at timely moments. Appropriate technological support, then, must be embedded in a work regime where a working division of labour involves socially distributed knowledge of several different kinds.

Shared expertise systems currently available are not wholly suitable for such an environment insofar as time- and safety- criticality preclude them. 'Expertise finding' systems, while they may evolve organically to meet some needs, at present cannot deal with the 'timeliness' problems we raise. Creating and maintaining a knowledge base does not really deal with the problem of 'emergence'. The development of such expertise sharing systems in this context may ultimately prove useful, but only if they support a community of practice that adapts to the organisational needs for knowledge exchange (Pipek and Wulf, 2003).

The likely way forward is some combination of new resources. We see a role for the 'map based' kind of technology which already exists - a role in which various forms of local knowledge are embedded in the system. At the same time, the problems of emergence, the social distribution of knowledge and the various forms which local knowledge can take, mean that it alone is unlikely to serve. It needs to be accompanied by, we think, two organizational and cultural shifts: the development of a culture in which knowledge is built and embedded organically, and a move towards a more strategic role for some operators, whereby they can support the immediate work of call takers and dispatchers. In principle, local

figures like shift leaders can be such experts in technological solutions. They could either provide knowledge directly or indirectly (on a 'knowing who knows' basis). The current case file does not contain all case related information and much of what could help in combining knowledge could be encouraged by a more elaborate case file where different kinds of information (map/comments/web pages etc) could be added. In a new and improved system it may be possible to provide more elaborate log, so that as much as possible of the operator's reasoning is visible in the case file. Another possible solution to the lack of local knowledge is to attach information, permanent or temporary, to addresses e.g. if a road is temporarily closed due to road work or if it is a festival going on (see also Halverson et al, 2004). These implications are dealt with in a current project where we have developed an emergency case handling and dispatch prototype that addresses several of these problems (see Normark, forthcoming).

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