Ambiguities, Awareness and Economy: A Study of Emergency Service Work

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ABSTRACT

This paper derives from a study undertaken at an emergency service centre in Sweden. The studies have focused on features of work familiar to the CSCW community, including the documenting and analysing current work practices, understanding the properties of the technology in question, and perhaps most importantly how the technology functions in and through use. Our focus in this paper exemplifies these themes through the analysis of two cases. In the first, the issue in question is the way in which an emergency is identified and dealt with, it being the case that a typical problem to be dealt with by operators, and more commonly in the days of mobile telephony, is that of multiple reporting of a single case. Of particular interest here is *listening-in*, which is a function in the Computer Aided Dispatch (CAD) system and by contrast that of 'overhearing', which is not. The second case focus on the relevance of wall maps, given the existence of computerized maps in these centres. Based on two cases from emergency service centres, we will show that the concept of awareness needs careful unpacking if we are to understand associated design issues.

INTRODUCTION

Swedish emergency service centres have historically worked on a local basis. The plan is, however, to develop new technology aimed at supporting the handling of different kind of calls across the centres. This idea is referred to as call distribution, or sometimes centre-to-centre cooperation. Call distribution is a common functionality in systems within call-centres today, and the next generation of systems are likely to involve a radical increase in that capability. One of the basic ideas is that calls may be handled anywhere at anytime, by operators using databases. Rather then being directed to the centre closest to the accident scene a call would be distributed to centres where the organization has unused capacity. In effect, this means standardising the technology in use across all centres and to some degree at least standardising work practices. One feature of this would be identifying knowledges and practices with a view to understanding how their possible attenuation might impact on new systems, or how new systems might incorporate hitherto local knowledges. With this aim in view, researchers from the Blekinge Institute of Technology have conducted ethnographic studies at four of the centres. These studies have been 'ethnomethodologically informed' workplace studies [10], focusing on the ordinary and mundane practices of competent members in a number of emergency call centres in dealing with calls, handling technology, and working together and singly.

Our interest was and is very much prompted by previous work in a range of centres, which either deal with safety critical work or deal substantially with coordination by telephone and radio. Analytically, our interests have oriented mainly to the identification of, dealing with and resolution of 'cases' since that is how operators organise their work, and indeed this organisation is embedded in the available technology. Based on two cases from emergency service centres, we will try to show in this paper that the general concept of awareness needs unpacking into its constituent and situationally relevant parts. We highlight the kinds of ambiguity that need resolving and the 'economy' of the work (by which we mean elegance and simplicity, rather than cost).

Related work

Studies of control rooms and related settings have by now become quite common. Early literature such as that of Hughes, et al [10] and Heath and Luff [8], [9], which looked at Air Traffic Control and the London Underground respectively, pointed to a number of features of cooperative working. Hughes et al noted how *no single factor* could be described as guaranteeing the mutual attentiveness that they observed, but that this was a culture saturated at every point with mechanisms, procedures, artefacts and orientations which made for reliable working, whether or not

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available information was accurate or up to date—indeed they made the point that information was *made* reliable by this complex amalgam of artefacts and practices. Similarly, Heath and Luff [8] pointed to the subtlety of some of these methods of coordinating work—how it was, for instance, that simple 'overhearing' acted as a means for information to be disseminated and acted upon, and how gesture, glance and other features of the economy of interaction were central to cooperative working. Similarly, they report on the use of displays to show the status of the line and how the timetable is used to plan the actions and make the flow of traffic smooth. One evident feature of such work was the focus on the role which various artefacts plays in working life. Thus and for example, Hughes et al [10] pay close attention to the way in which flight progress strips are handled, manipulated, written on, pointed at and shared with others as a means of checking, verifying, updating, and pointing to the status of aircraft in the sky. The flight strip, then, is an artefact-in-use which has proven difficult to replace perhaps because of the sheer richness of the functions it can perform.

Other research has similarly identified how artefacts in control rooms may be used to furnish problem solutions, prompt mutual awareness, and act as a locus for coordinated activity. Suchman's notion of 'centres of coordination' thus begins to suggest some common features to be found in control rooms of this kind (see [6], [14] [15]; Watts et al, [16]. In our reading, 'centres of coordination' consists of a collection of settings where people are co-located and engaged in solving problems and work tasks, which relate to places other than their current location. Research on coordination centres often considers how peoples' interaction with artefacts, for example computers and monitors, provides a way of letting others become aware of what is being done and acts as a resource for an evolving working division of labour.

These issues, which have to do with the particular ways in which artefacts function and the subtleties of work practices, remain vibrant and have informed recent work in coordination centres of a quite different kind. Thus, Button [5] describes the scheduling-board in a print shop as an example of coordination. The scheduling board is used to picture the current production (p. 329). The flight strips and scheduling boards, then, are representations of both the current and the prospective state of play. Moreover, the scheduling board, in the same way as the rack of flight strips, is there even if other technology breaks down. Work of a more general kind, including for instance, Sellen and Harper [13] also points to the materiality of artefacts-in-use and the functionalities associated with them. None of this, however, suggests the *necessity* of the associated practices in question. For instance, where Hughes et al stress the 'at a glance' public availability of flight strips, Berndtsson and Normark [3], whilst acknowledging the continued coordinative value of the flight strip, point to how video can be used to good effect in some European centres as a means of monitoring the status of strips and thus of work between control centres, without 'public availability' necessarily being a feature of the artefact-in-use. It would seem, then, that while such studies stand as testament to the powerful meshing of cooperative work and artefact - the reality of 'current practice'- they should not be read as 'conservative', for 'no change' has never been a starting point for such studies, even if they do act as 'cautionary tales' for those who precipitately advocate the move to radical new technology.

Nevertheless, there are dangers in such studies (regardless of work context). Firstly, there is the potential reification of concepts such as attentiveness and awareness. Such a tendency would involve merely looking for examples of 'awareness' on the grounds that this would constitute an adequate analytic relevance for design. We are not at all sure that it would. In some ways, then, this paper is a reminder that attention to the specificities of the workplace is always necessary. A second danger lies in a tendency to view conclusions about awareness as conservative in the sense of challenging the need for technical innovation. Emergency room studies need not be read this way. Rather, their several different analytic interests can be seen jointly as emphasising the way in which awareness and other phenomena can act as techniques for resolving various kinds of ambiguity in economical ways. In these studies, as with our own, *ambiguity resolution* is a core problem for operators. Their mutual awareness is *only sometimes* deployed to resolve problems. We have something to learn about the occasions upon which awareness is relevant and those where it is not.

In this light, we turn to studies, which have had emergency services as their specific focus. We focus on three in particular, and note the different focus of each. Firstly, attention has been drawn to the sense making work entailed in call-taking. Whalen [17], in particular, has studied this work in some detail. Whalen describes a locale where emergency service work is performed, as elsewhere, by staff who are typically separated by role into call-takers and dispatchers. Nevertheless, Whalen's work is not in the main about cooperation between the call-taker and other colleagues, but about cooperation between call-taker and client on the telephone[1]. In the centres in question, Computer Aided Dispatch (CAD) technologies not unlike those in the Swedish centres were employed in an effort to provide a level of standardization. Whalen shows how call-takers' work can be understood as an immediate, local, sequential progression, organised around the occasioned need to identify what kind of problem is at stake and how it might be described. We cannot do justice to the sophistication of Whalen's analysis here, but point to the way in which the sequential ordering of interaction and talk here takes place around the input requirements of the CAD system - are made nameable and countable organizational events—but are not determined by them.

Secondly, work has been done which shows the thoroughly cooperative nature of dispatch in an ambulance centre in the

[1] Other studies in recent years have also begun to focus on customer-facing forms of cooperation. See for instance, Harper et al [13]

UK (see Martin et al [11]; Bowers and Martin [4]. These papers focus on the collaborative work of dispatching (in centres which also separate call-taking and dispatch functions). Bowers and Martin describe dispatch work as, 'display-inspection-and-manipulation-work' (p. 317). They allude to the way in which information is distributed such that 'the information they need for their job is at hand, and readily so …' (p. 318) and go on to suggest that, 'It also ensures that if workers need become aware, for whatever reason, of information *not* accessible from their own screen that they engage in embodied activity which makes the fact that they are doing so available to others in the control room.' (p. 318). Contained in this argument is a forceful justification for information distribution done in such a way that enough information and no more is distributed to each member in the control room. One technology they discuss in the light of their analysis is the 'Automatic Vehicle Location System' (AVLS). They suggest that this map-like system is used relatively infrequently (indeed, screens are often turned away from operators) for reasons which include the need to scroll through the map in order to ascertain the position of different ambulances; the difficulty of estimating distance in comparison with 'reading off' figures on other resources; and the fact that proximate ambulances tend to appear 'on top of each other' on the screen. In contrast, they argue, and in keeping with results from Air Traffic Control (Hughes et al, ibid), other resources provide 'at a glance' solutions. This observation concerning what we will term 'relative economy' is, in effect, the starting point for our own analysis below. Nevertheless, our observations took place in a centre where computerised maps were regularly used, with wall maps being referred to on occasions.

Artman and Waern [2] have identified the way in which mutual attentiveness is guaranteed in a Swedish centre through 'talking to the room', reporting on work in a Swedish emergency service centre which forms part of the organization that we are concerned with. They are perhaps the first to look at coordination across the various roles within an emergency centre room. They present the work as having an 'event driven' character, and suggest that one major consequence of this is that operators do not know in advance when large-scale events will occur. Given that resources are, by definition, scarce, emergency services work orients to 'coverage'. That is, the dispatch of ambulances must be done with one eye on the possibility of unanticipated and potentially serious incidents. Thus, "The operators must always try to save some resources for the next possible incident. This means that the ECC's [Emergency Coordination Centre] resources are scarce and this is a major constraint on the ECC's work." (p. 186) They present examples, using a distributed cognition perspective, where operators cooperate in the handling of cases, and where the cooperation described is explicitly supported by a function in the CAD system called *listening-in*. Notwithstanding this function operators, they suggest, typically repeat the caller's utterances aloud. Moreover, they do so with no particular recipient in mind, i.e. they 'talk to the room'. This undirected talk serves as a check that what has been understood is correct (in much the same way as pilots repeat the instructions of Air Traffic Controllers) and just as importantly an elegant and economic way of informing 'the room' – i.e. colleagues – what the call is about.

All these studies, on the face of it, focus on different matters in broadly similar control rooms. Whalen studies the way in which calls are managed; Martin et al the way dispatch is conducted, and Artman and Waern [2] the way in which 'awareness' and undirected talk can be identified regardless of the existence of sophisticated technology. We will argue, based on our own studies and the above, that all this work can be subsumed into a general category of ambiguity and more importantly that specific forms of ambiguity can be identified.

The studies of emergency service centres

The SOS Project is an ongoing research project, which aims to explore current and potential connections between work practice and design. One major focus of interest has been the fact that there is considerable variation between the various centres (which number twenty in all), in terms of their size (the largest serves between one and two million inhabitants), their responsibilities (accident and emergency management is, for instance, very different between urban and rural centres), the technology in use (since different versions of the CAD system were in use in different centres) and their work arrangements (in some centres, for instance, call and dispatch functions are integrated, and in others they are not). Data collection was done largely through the presence of fieldworkers engaged in the usual business of note-taking, video recording, asking questions and so on. Observation sessions typically lasted between two and four hours. Depending on which centre being observed, up to three cameras were used simultaneously to record data. The CAD in use in the centres contains information such as plans for responses, event codes, lists of available resources and 'cases'. Data logs from the systems were available to us and we frequently used them in conjunction with observational data to resolve otherwise ambiguous situations. These logs and the video material proved invaluable since many events took place in a fluid and rapidly changing nexus of actors and technology. Events can unfold with great speed, and in parallel. This concurrency was the main reason why log and video analysis proved so fruitful.

TWO CASES

The two cases we proffer demonstrate some issues that we feel are germane to call-distribution.[2] The two cases are about traffic accidents. The first case (The Knothult case) concentrates on how multiple calls are identified and how operators go about handling the case when they identify the calls as involving a single case. The second case is also about two calls, but in this instance the second call arrives to the centre about six minutes after the first one and involves the same caller. Here we will see how the operators take the opportunity both to be updated by the caller and update the caller about actions that are taken.

[2] Though not all. We do not, for instance deal with the importance of local knowledges. See Normark [12]

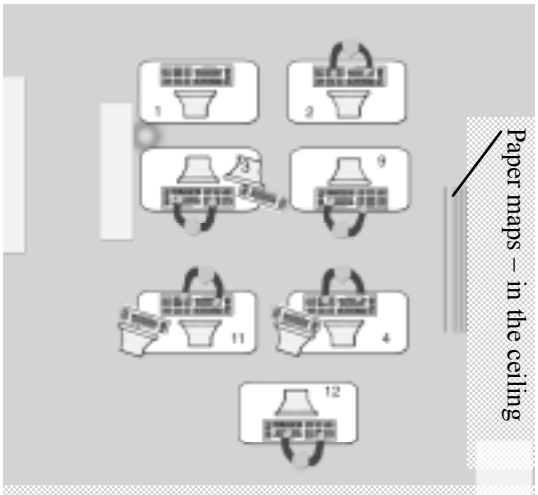


Figure 1 The picture shows an example of a layout of a SOS-centre. The operators have different roles. E.g. the ambulance cases are mainly handled at terminal 11, 4 and 12. Rescue service (e.g. dispatch of the fire brigade) cases are handled at terminal 3 and 9. Terminal 1, 2 and 12 are used as general terminals, handling many different kind of calls.

Before looking closer at the cases, let us give some background to the setting and the work carried out there. In this particular centre, several CAD-terminals are in use, and operators have different and specific roles to perform. Operators to answer calls, describe events, follow pre-defined plans and see the status of available resources, as suggested, use CAD. The system is an integrated telephone switching and database system. Another system in use in some centres is the computerized map, which shows the updated status and the position of ambulances. Equally, and roughly akin to sectorisation in Air Traffic Control, a given operator has the main responsibility for a specific area. In addition, the table where the operator sits receives only certain calls available from the call-queue.

The separation of calls has a practical implication for how the work is carried out, since the operators can log in to different *profiles* accepting only calls to certain lines. Those profiles are based on a general division of responsibility within the traffic room that consists of roles. The *ambulance director* (terminal 11) is responsible for keeping track of ambulances within a specific region. Keeping track of ambulances involves knowing where the ambulances are, which assignment they have and what their current status is. Some centres have several ambulance directors working in parallel with different geographical areas of responsibility, but here there is only one at a time. By default ambulance directors do not answer emergency calls, but rather dispatch ambulances and make calls to the personnel in them when there is a need for clarification or feedback. Next to the ambulance director, at terminal 4 is the *ambulance assistant* whose main responsibility is to answer emergency calls, health-security services and answer the public lines for non-emergency ambulance requests. The third role is that of *automatic alarms*. This role also accepts emergency calls. The fourth role is responsible for the dispatch of rescue services such as the fire brigades (terminal 9). Occasionally, e.g. at peaks, there are terminals used for more general services—accepting all or nearly all kind of calls, i.e. terminal 1,2 and 12 (See figure 1 for a layout of the traffic room.).

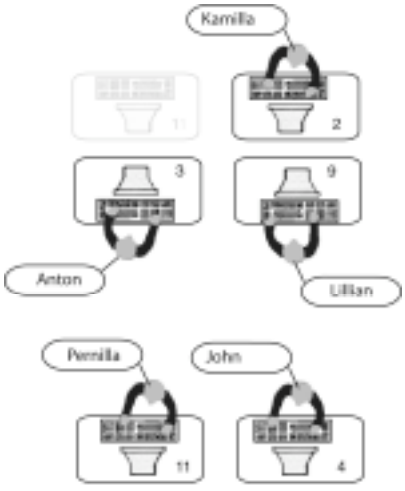


Figure 2. An overview of how the operators are positioned in the beginning of the Knotshult case (case 1)

Case 1 - The Knothult case

The operators that are involved in this case are Pernilla (terminal 11), Anton (3), Lillian (9), and Kamilla (2) (see figure 2). The case in question concerns a traffic accident. Two cars hit each other during the afternoon, and shortly afterwards two people make separate calls the emergency line (112) to report the accident. Two different call operators answer the calls. These operators then create two separate cases, which subsequently are re-configured into a single case.[3] Our analysis deals with the way in which two different operators are involved in dealing with these calls, how others are enlisted to 'listen in' to the calls in question and subsequently how responsibility is allocated and accepted. The case lasts an hour in total but our interest is restricted to the first five minutes.

The calls arrive to the call-queue of the centre a few seconds apart. The first caller is a man passing by in his car. He calls from a mobile phone. Kamilla answers this call at terminal 2. A woman calls the second call from a kiosk near the accident scene. Anton at terminal 3 answers this call. Both operators start to interview their callers.

The first transcript is taken from the call at terminal 2. The callers voice has been available for us to transcribe from the recordings the emergency service centre makes of all calls. Since the conversations are going on in parallel, we include within parenthesis the timestamp taken from the emergency services own recordings of the calls.

1 (15.50.05) Kamilla: SOS 112 … what has happened?
2 Caller (Man): Yes, Hello, is it the emergency centre?
3 Kamilla: Yes

[3] For privacy reasons all data about locations, phone numbers etc. in the field material have been removed.

4 (15.50.15) Man: There has been an accident here in Knothult
5 at the Babelstreet outside the Fast food
6 place… can you send…
7 Kamilla: Is it a traffic accident or … yes?
8 Man: Yes … here on the crossing
9 Kamilla: Yes, are there people injured?
10 (15.50.25) Man: Yes, shock and a person injured … no bleeding
11 that I can see
12 Kamilla: Is it just a single car accident or…?
13 (15.50.35) Man: No a double … it's an eldery man that=
14 Kamilla: =It is two=
15 Man: has driven right on to the crossing here=
16 Kamilla: =it is two=
17 Man:And it is two… Germans that have hit trouble=
18 Kamilla: It is. What was your address there?
19 Man: It's in the Babelstreet, quite early on … at the
20 Gas station, so it is that way = around 66=
21 (15.50.45) Kamilla: At the The Gas Station? (sound of women
22 hat cries/yells in the background) 66…66
23 (15.50.55) Kamilla: At the Gas Station?
24 Man: 75 they say here
25 Kamilla: And the crossing you say
26 Man: Babelstreet, Askrikegatan
27 (*15.51.00*) Kamilla: Is it in Knothult?
28 Man: Yes, it is in Knothult
29 (15.51.10) Kamilla: Fast food place (sounds in the background:
30 my husband, he) and it is two persons injured,
31 two persons injured or?
32 Man: Yes

The caller gives information about the accident, saying, "There has been an accident here in Knothult (…)". Kamilla asks whether it is a traffic accident or not (line 7). On receiving a positive answer, she asks, "Yes … are there people injured?" (line 9). This 'yes' may be seen as a confirmation to the caller and makes the answer accessible for the others in the traffic room in much the way that Artman and Waern [2] note. It also elicits information concerning the relative seriousness of the event. She does not repeat that information, but asks "Is it just a single car accident or …?" (line 12), and further elicits the information that that two cars are involved. She repeats this two times (line 14 and 16). The caller also specifies what has happened, "an elderly man" has driven onto a junction, without giving way for the traffic. The caller adds that two Germans have hit trouble. "It is" (line 18) may also serve as information to the other colleagues or clarification of the question about how many cars were involved. It is also an assurance that Kamilla has understood that at least two people are injured and need assistance.

In the interview Kamilla asks a set of questions about "what and where". She then uses an event code which describes a collision between two private vehicles. The case that Kamilla creates gets an identification number (number 421) and is created in the CAD. When created the case becomes available for her colleagues to access on their screens. This means that it also becomes visible in the list of "ongoing events", by the event code, the address and zone. At the time when Kamilla answers the call, Lillian (the rescue service dispatcher) is handling another call. She ends the conversation by saying "Then I'll do it like that, thanks, good bye" about three seconds before the beep is heard. The listening-in request becomes visible in the call-queue. Lillian chooses to answer the internal communication line. The case (421) appears on her screen when she answers the listening-in.

At line 25 in the transcription above Lillian leans forward, resting at the table. She stands up, and moves her left hand towards her ear, where the earphone for her headset is positioned. She says:

26 Lillian: Is it in Knothult? (She nods)
27 (*15.51.00*) Kamilla: Is it in Knothult?
28 Man: Yes, it is in Knothult

Lillian sits down again and presses the hang-up key at the keyboard. Five seconds later (corresponds to line four in the first extract), Anton answers the second emergency call at terminal three (3):

1 (15.50.15) Anton: SOS 112 what has happened?
2 Woman: Yes, hello, I am calling from Knothult,
3 there's been a traffic accident.
4 Anton: You said a car accident?

Anton requests listening-in. He directs the request to all operators. A beep is heard. Anton continues:

5 (15.50.25) Anton: what has happened … have two cars collided?
6 Woman: two cars have collided.
7 Anton: Two cars have collided … does there seem
8 to be anyone injured?

In line 4 Anton says -"You said a car accident". This repetition what the caller said can serve both as a check that he understood correctly and a way of making the colleagues aware of that he is handling a traffic accident. In the next sentence he asks if it is two cars that have collided. Kamilla (at terminal 2) asks if it is a single car accident, and in line 10 (see the transcription for terminal 2) says "it is two". This is said at the same time as Anton asks whether or not two cars are involved, suggesting that he has overheard the conversation at terminal 2.

9 Woman: It appears so, because I work in a kiosk, and I
10 can see something outside … I think that it's two
11 girls and one older guy.
12 (15.50.45) Anton: Are they still in the car?
13 (15.50.50) Woman: The guy is still sitting there.
14 Anton: The guy is still sitting in the car
15 Woman: Yes, wait a minute. I'll look outside the window.
16 Anton: Which address is it about?
17 Woman: It is Fast food place, here at the Babelstreet 1

Anton continues to repeat what the caller says. At line 12 he asks – "are they still in the car". At this moment Pernilla (the ambulance service dispatcher) answers the listening-in function and listens to the call. The caller asks Anton to hold while she takes a closer look. He continues talking with the caller and asks for the address.

18 (15.50.55) Anton: Babelstreet 1 outside Fast food place
19 Woman: Yes
20 Anton: In …
21 Woman: Knothult
22 Anton: In Knothult
23 Woman: Yes
24 (15.51.05) Anton: Yes…. Okay, my colleague is dispatching there
25 (15.51.10) already but it's two private cars involved?
26 Woman: Yes, it is this transport wagon
27 (15.51.15) Anton: Yes … can you take a closer look?
28 What is it like there? My colleagues have
29 already started to send an alarm to the rescue
30 service here
31 Woman: Yes, wait

At this moment Pernilla listens to the call. She hears the repetition of the address. What Pernilla does is visible in the system. For example, Anton says that his colleague is dispatching already. This information becomes visible as a text notification on the screen.

32 (15.51.30) Anton: I will wait here on the phone

At 15.51.05, Lillian turns her head towards Anton at terminal 3 and says:

29 (15.51.05) Lillian: Traffic accident in Knothult

This is information addressed to all colleagues. Anton turns his head towards Lillian and nods. Pernilla, who has answered a listening in request from Anton about 10 seconds before Lillian, says:

30 (15.5115) Pernilla: I am on my way.

Pernilla turns towards Lillian and continues:

31 Pernilla: Anton has it. It is two cases. It is the same
32 case as Anton's.

She turns towards her screen again. Lillian says:

33 (15.51.25) Lillian: Oh, Okay

We see here how Anton and Pernilla realize that they are dealing with the same accident as Kamilla and Lillian. Anton's nod may be an indication of this. That Pernilla says, "I am on my way" also indicates that she is also aware of this fact and is dispatching. It is worth pointing out, however, that no overt questions are asked to establish whether it is the same accident, or another one. Pernilla also explains not only that Anton has the case, but also that it is two cases, and that they are the same. At this moment both cases are created and visible in the list of ongoing events. The cases have the same event code and the same addresses. The list of ongoing events makes the calls visible. That the operators identify calls from the same accident scene and cases that are created parallel to each other is rather common in our material.[4] Frequently, we have observed, a third person notices that two apparently separate cases may in fact be one. As a check, the call-takers normally ask a clarifying question of their caller. If the case is the same, one of the cases is associated to the other one. This association is made by addending a note about the other case, or by associating the incoming call directly to the other case. In this instance, Lillian tells her colleagues about the traffic accident in Knothult, and the reaction of her colleagues, where one of them nods and the other says, "I am on my way", suggests they were already open to this possibility. The "Traffic accident in Knothult" phrase then can be heard as confirmatory and stands as a marker for everyone that this is to be treated as one case.

Identification of the case as a single case is done in and through awareness of and attentiveness to the work of others, as has been reported elsewhere on numerous occasions. However, the issue is precisely why these mechanisms operate in this case but not in others. The answer lies in the fact that operators have a considerable background knowledge here, part of which concerns the likelihood of duplicate calls. That is, they are on the lookout for such phenomena, but have to be sure that they are indeed examples of duplication. The specificities of the work lie in the fact that awareness is occasioned by the prospect of a case duplication, and the work done around this is a simple and elegant way of resolving it. As has been pointed out [10] a range of background issues may underpin work practices in control rooms, including those of economy, expedition and safety. In and through the analysis we have proffered above, we attempt to show that mutual awareness here is simply a means to accomplish a relative economy of work. Moreover, it is occasioned by a quite specific problem (and one which Whalen adduces), which is that of ambiguity with relevance to the number of incidents. Here, however, the ambiguity is resolved by cooperative work, both in terms of the interactional work done by colleagues and the work done with callers. The decisions made concerning the case are made precisely because there is an issue of resourcing to contend with, specifically with regard to the dispatch of multiple resources, as Artman and Waern (ibid) have pointed out, but in addition with regard to matters of expedition—as the telephone conversation continues, ambulances and fire trucks are already being dispatched to the scene, and indeed the first ambulance arrives at the scene moments before the first telephone call is terminated. In the following case, we illustrate this theme of relative economy and ambiguity resolution further, by referring to the use of maps.

[4] In war-stories told, the operators and managers talk about calls made to the emergency service centre about smoke, visible at long range, in a large city, which resulted in calls from more than 600 people.

Case 2: The traffic accident outside a town

The following case has some similarities and some differences to the other case. It concerns a traffic accident outside a town. Several operators are involved in the case. Karin is the call-taker and sits at terminal 9. The second operator involved is Sabine, who is on her break and temporarily sits between terminal 9 and 3. The third operator is the ambulance director, Erika. A few minutes after the first call is terminated, Alex answers a second from the same caller as before. Our description covers the two calls. We had no access to the caller's turns during the first call, but were able to hear him during the second call. Unlike the first case we have not had access to the emergency centres own recordings.

The first call

At the time the first call is answered four out of six operators in the room are involved in a conversation and are placed as is shown in figure 3:a. Karin answers the first call reporting the traffic accident. She starts to interview the caller about what has happened and where it has happened. She requests listening-in, which is answered by Erika at terminal 11. Karin says:

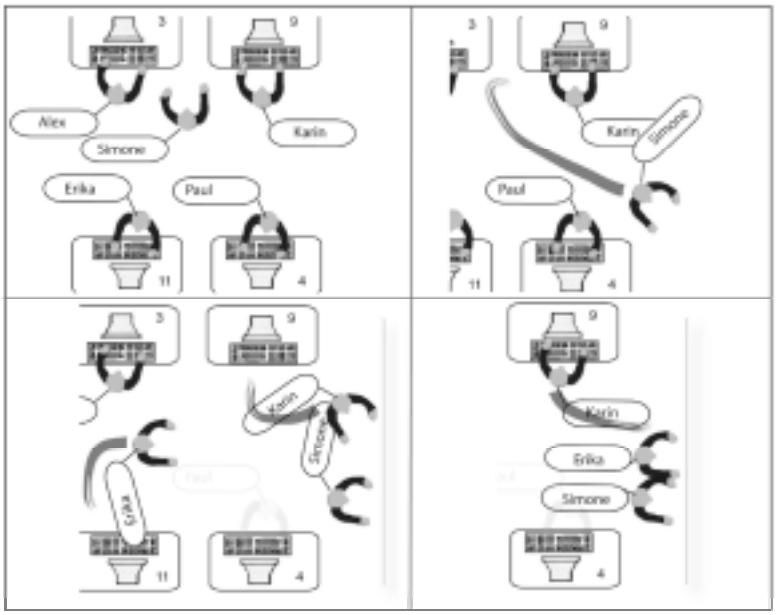
1 Karin: Yes, you mean the road from Torstad ….
2 do you mean the 52 then?
3 Karin: Yes … you know we have to know where you
4 are. You can take… where did you come from?
5 Karin: You came down the slope, then … down the hill...

Sabine rises and walks towards the maps hanging from the ceiling (see figure 3:b). Just before she stands up she looks at Karins screen. She pulls down the map that corresponds to the area of the accident. When the map is down Karin rises from her chair, walks towards the map and continues to speak with the caller (see figure 3:c).

Alex turns her head towards the map just before answering another call. Sabine and Karin point at the map. Erika walks to the map. Her headset is still connected to the CAD system, indicating that she is listening to the call. All three of the operators look and point at the map. Karin returns to her seat and enters some information into the case form. She tells the caller:

6 Karin: My colleagues are dispatching while we are

a) b)



c) d)

Figure 3 The sequence of pictures shows a) before the call is answered b) when Simone walks to the rescue maps c) when Erika walks to the map and d) when the operators gather in front of the paper maps

7 talking.

Erika in front of the map turns towards Karin, and says (figure 3:d)

8 Erika: Is it the exit to Erikslund
9 Karin: Not Erikslund, but the other one?
10 Erika: Ask about the road description (Erika looks at
11 Karin)

The wall map is used in order to fix the position. In this case, however, the operators are also figuring out how to make it easy for the fire brigade and ambulances to find their way to the accident site. Karin asks questions about where and from which direction the caller has come. She asks those questions just before Sabine walks to the map and pulls it down. Sabine at Karin's screen sees what is typed in, and also hears what is said. The way it is said may also indicate the seriousness of the incident, or an uncertainty in the information given by the caller. For example Karin interrupts the caller by saying, "You can take… where did you come from?"(line 4). Erika has answered the listen-in request that Karin sent and can hear the caller. What Erika says is also heard in Karin's headset.

The second call

Alex looks towards the colleagues in front of the map during the first call, but does not participate in handling this call. Instead she sits at her position and answers other calls. About six minutes after the first call is terminated, Alex answers a second call about the same accident.

1 Alex: SOS 1-1-2 what has occurred?
2 *Caller: I called a while ago*
3 Alex: What was it about? (Alex raises her left arm
4 towards her ear, fixing the headset, leans
5 forward, moves her right arm.
6 Karin is in the front of the map and is
7 pointing at it. Talking to someone on the phone.)
8 *Caller: It was about a traffic accident at road 52.*
9 Alex: The traffic accident, yes

When Alex answers the call the location of the call is visible in the call queue. Alex identifies the call as being about the above accident, one that she has not been involved in (line 9). What has been done in the case is visible in the room. The second call arrives as the units are dispatched and the operators involved in handling the case are occupied giving road descriptions and general information about the case to them. No dispatch unit has yet arrived at the scene. When dispatching the fire brigade and the ambulances the operators are talking via loudspeakers at the fire station and in pagers with voice enabled. Sometimes operators contact the units via phone or radio in order to give updated information about the scene. Karin is in front of the map and is giving a road description to some of the units on their way. Alex continues the interview:

10 *Caller: A collision.*
11 Alex: Are you still at the location?
12 *Caller: Yes I am*
13 Alex: Eh, have you been involved in the accident as
14 well?
15 *Caller: It does not look good*
16 Alex: Are you involved in the accident too?
17 (Alex presses at the keyboard and navigates
18 through the case forms.
19 She associates the call with the traffic accident
20 case. She looks at the screen.)
21 Caller: Yes I collided with a car
22 Alex: Yes, the fire brigade and the ambulance are on
23 their way to you
24 Karin: Drove the 55. (Alex looks at the sub-form for the
25 fire brigade. Karin is in front of the physical map.)
26 *Caller: Will they come soon?*
27 Alex: Yes
28 Caller: It does not look good with him
29 Alex: Yes, the man in the private car?
30 Caller: Yes
31 Alex: is he alone in the car? (Alex leans forward.)

The information is stored in the database and Alex accesses it. She does not ask anybody about the case, but has been looking at what her colleagues have done before. She has also overheard the conversations and seen which artefacts have been used. Alex takes the opportunity to ask questions about what happened. The caller gives more information about the accident and also updates the centre with regard to the injured person. Alex accesses the CAD system

(line 15) and looks through the cases. In the case in question, she can see which units are dispatched and if they have acknowledged the dispatch to the centre. One of the ambiguities to resolve is the status of the person in the car, and further questioning helps to clarify the situation. In the following extract, Erika, the ambulance director, tells Alex to ask for the road description to the location again (line 33).

32 *Caller: Yes he is. At least as far as I can see.*
33 Erika: Ask about the road description, just to be sure
34 Alex: Yes
35 Alex: Ehh, it was approximately two kilometres along
36 road 52, was it?
37 Karin: A couple of kilometres along there. (Karin
38 returns to her terminal.)
39 *Caller: Yes, it was.*
40 Alex: How far was it?
41 *Caller: I have driven a little way from the 52.*
42 Alex: Yes, a little distance. There is no chance missing it
43 if you are
44 entering from that way is there?
45 Karin: This person was stuck in the Car. (Stands up.)
46 *Caller: No, it was right after a downhill slope*
47 Alex: Yes. Yes. It was the downhill slope you talked
48 about before, then? (Alex is on her way to the
49 map.)
50 *Caller: Yes. When will the ambulance come?*
51 Alex: They are on their way so they will arrive as soon
52 as possible
53 (Alex looks at the map, turns around and walks
54 back to her terminal.)
55 *Caller: Good.*
56 Karin: He knows that you are on your way. (Karin looks
57 at the map)
58 Alex: How are you now then? (Alex is back at her
59 terminal. Sits down.)

Alex enters the handling of the case when answering the second call. When doing so, she looks up the traffic accident in the list of ongoing cases. She does not directly speak to any of the operators about this—but when she enters the information into the CAD system, it becomes available for the other operators. The ambulance director, Erika, also asks Alex to get the address once again.

This case contains several aspects related to economy, ambiguity and awareness. To start with we should be aware that the actions of colleagues are visible both in the database and in the room. They have computerised maps to which they can and often do refer. However, in this case we see operators orient to the paper map, which is pulled down early in the first call.[5] Here, however, it is notable how at different times more than one operator pays close attention to it, again because ascertaining the location with any certainty is proving difficult. There is, however, a difference in that an entirely new operator becomes involved in the call. Her reactions to the caller's remarks can be seen as orienting her colleagues to the relative seriousness of the event just as at exactly the same time she establishes what the current state of information in the room is, and judges it against what she is being told by the caller. In this case, we focus on yet another element of ambiguity resolution, though, which has to do with the seriousness of the case (note that this element is also present in Case 1). It is obvious from the caller's remarks that he is worried about the situation and Alex's leaning forward can be seen as a response to this. The very careful checking done by Alex after colleagues have already identified the probable location, and their question, 'There is no chance missing it if you are entering from that way is there?' at the same time that Karin says, 'this person was stuck in the car' is plausibly recognition of the prospect that this is a bad accident.

[5] Interestingly, one way in which operators' attention is focused on the wall map when in use is that it is motorized, and thus makes a noise. A light also switches on automatically above it, serving a similar purpose.

CONCLUSION

As we have observed above, we are not the first to take an interest in Command and Control work, nor even in the specific case of emergency service work. Nevertheless we note the widely differing focus of existing studies, and seek to integrate their findings with our own in such a way that some general conclusions can be drawn. Our questions depend on our sense of 'what we need to know' if useful design recommendations are to result. Existing studies have all, in turn, provided insights into aspects of emergency service work. Thus, Whalen concentrates on the sense making work of operators on the telephone and makes a case concerning its necessity for 'case making'. Artman and Waern develop this argument by looking at interactive work among control room operators, showing that 'talking to the room' is a technique for getting attention from others, and thereby allowing collaborative work to take place. Bowers and Martin [4] in a detailed study of control room functions suggest reasons, as part of a wide-ranging discussion, why wall maps in their study are a default option and electronic screen-based maps are seldom used among dispatchers. They suggest that the 'at a glance' immediacy of these resources explain their use. These separate issues of sense-making; 'awareness' and immediacy need some integration.

It is important to recognise that collaborative working, in the sense that visible interaction is going on during the development and management of a 'case', may be only trivially necessary. That is, collaboration between call-taker and dispatcher may take place merely because the occupational roles of call-taker and dispatcher have been organizationally defined and mandated. What is much more interesting is the way in which specific types of collaboration around sets of artefacts are occasioned by specific kinds of incident. Two things spring to our attention from the above data. Firstly, as has been shown by previous studies, is that these forms of 'attentiveness', 'awareness', directed talk or 'talking to the room' sometimes take place even *where facilities exist for mediating collaboration electronically*. Thus, as in the case above where wall maps are put to use, the issue is why it is that electronic maps are adequate at other times but not on these occasions. Moreover, our cases show the way in which the 'awareness' work that we and others have discussed is not a default way of doing work, but is engendered by quite specific and commonplace 'routine troubles'. After all, and perhaps it is a point that needs foregrounding, some work is done without the need for any kind of cooperation other than that which is mandated. Other situations seem to generate the visible overhearing, gesturing, glancing and gazing frequently ref-

erenced in the CSCW literature. This is as much true of emergency services work as of any other, and we suggest that awareness work here is prompted by the need to resolve certain ambiguities that typically arise. The data we present above shows how the kind of attentiveness described is not a generalised phenomenon but is in fact specifically occasioned by a situation, which becomes recognisable as problematic as the interaction develops.

How, then, is this 'problem' constituted? We propose some analytic categories to do with different kinds of ambiguity here that are germane to the design problem in emergency service work (there may well, of course, be others) Initially, however, and as has been pointed out [10] a range of background issues may underpin work practices in control rooms, including those of economy, expedition and safety. At least two organizational requirements are relevant here. The first and most obvious is that of the time-critical nature of the work (Bowers and Martin, ibid). To be clear, we do not mean time-critical simply as a generalised background to descriptions of command/control systems, but in the sense that operators visibly orient to time as a feature of ordinary effectiveness, as is evidenced by comments such as, 'I'm on my way …', the use of functions such as listening-in, and the dispatches done in parallel. The second is that cases must be prioritised, since some will certainly turn out to be more serious than others. That is, and as suggested above, the relative economy of the work practices we observe can be understood as having to do with the orientation of operators to these issues.

We see how, in our first example, one of the operators says "Traffic accident in Knothult" and the operator at her side nods while another says "I am on my way." That is, and put simply, identification of the case as a single case is done in and through attentiveness to, or awareness of, the work of others. Nevertheless, we should not lose sight of the fact that it is an *ambiguity about multiple calls* that engenders the cooperation. The operators in our first case realize that they are dealing with the same accident and use elegant, quick and simple methods to expedite the case. In so doing, they utilise both the electronic resources at their disposal and their 'awareness' to resolve the initial ambiguity. They continue to work in the case that was created first, i.e. the second call answered, and we note how ambulances and fire trucks are dispatched to the scene as the call continues, and in fact the first ambulance arrives at the scene moments before the first call is terminated. Fundamental to this work is the fact that it is done in parallel.

Our second case, we feel, is a vivid demonstration of the need for cases to be expedited, and is an example of how *ambiguities about location* can generate the parallel working that stems from awareness work. It also, however, illustrates the sometimes-problematic matter of organizational priorities. SOS, as with other ambulance services, has to decide on priority. Part of this is dealing with the simple fact that some percentages of the calls received are hoaxes, but nevertheless require finite time to deal with. Similarly, there is an ongoing issue of the immediacy and seriousness of cases to which operators visibly orient. Our second case also shows how *ambiguities about immediacy and seriousness* can arise and need to be dealt with. The ambiguity lies in the need to allocate priority in the face of ambivalent, inadequate and uncertain information. These decisions are, of course, embedded in the CAD system as formatted results during the course of, and as an outcome of, the interactions detailed above. As the case demonstrates, this has very much to do with how serious any given incident might turn out to be. We think it reasonable again to see the cooperative work in this case, and specifically the work of an operator not previously involved in it, as occasioned by the growing realisation that something serious has happened. Indeed, the very fact of the second call seems to alert the operator in question to that possibility and much of what she subsequently does can be seen in those terms.

In our cases, and from the point of view of the call-takers and dispatchers engaged in working on them, their 'routine troubles' can be seen as ambiguity resolution work. Our point would be that this can be seen analytically as having consequences in terms of the organization of cooperative work, for it matters both in terms of the prioritisation of cases and in terms of the time criticality. Ambiguities may of course take a number of forms, and our cases illustrate three commonly occurring ones, which are those of multiple calls, location finding and the seriousness of the case. (Of course, these things are sometimes found together.[6]) In all instances, the cooperative work we see is an elegant, 'at a glance' solution to these problems, insofar as the work is, on these occasions, done in parallel rather than sequentially.

To sum up, in terms of design we want to re-iterate a sometimes forgotten point, about the foundations of ethnomethodological studies of the type advocated by Hughes et al (ibid). This lies in their debt to Garfinkel's ethnomethodological studies of work programme. Garfinkel makes explicit reference to the 'quiddity', or 'just this-ness' of a given situation, and makes a strong argument for situations to be understood in terms of the way members understand them. Critically, of course, in work contexts, members orient to work in terms of assumptions about what the work is for, how it is to be done efficiently and effectively, what sanctions there might be for inadequate performance, the morality of 'doing the right thing' and so on. Such orientations are made visible in matters of egological determination [1] and are evident in the case we study here. Our point is that 'what has to be done, and by whom' is resolved in this case, as with others we have observed, because, given available technology and organizational resources, members are orienting to this solution as the most elegant or economical, especially in terms of time taken.

The design lesson, in our view, should not be that new technology should be designed with a view to replicating

[6] We do not mean to suggest that we exhaust the possibilities either in our description of types of ambiguity resolution nor in terms of the organizational requirements that drive them. We hope that others will be recommended in due course.

'awareness', but that it should be designed with a view to providing more effective solutions in terms of time taken, ambiguities encountered and resolved, resources used and so on. The new technology to be developed adds possibilities for new or improved functions, e.g. call distribution or centre-to-centre cooperation. Although the degree to which call distribution will be implemented is as yet unclear, it has implications for at least some of the forms of ambiguity resolution we discuss above. The examples of cooperative work we use are all predicated on co-location for their effectiveness and simplicity. Major issues for design under call distribution are implicated; for without adequate technological support it is unclear how the kinds of problem we have rehearsed can be dealt with as expeditiously.

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