

SUPPORTING FIRE CREW SENSEMAKING ENROUTE TO INCIDENTS

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Abstract: Reconstruction of major emergencies and crisis as well as observations of large-scale emergency exercises are common approaches for studying and understanding various actors work practice in emergency response. Studies of small-scale emergencies using an ethnographic approach are less common. This paper presents data from a single small-scale emergency as part of an extensive ethnographical field study. A detailed analysis of fire crew enroute sensemaking in a single small-scale emergency is outlined. The theory of sensemaking is applied as an analytical lens aiming to explain the communication between the command centre operator and the fire crew in terms of sensemaking. Further, implications for design of information technology use for fire crew enroute sensemaking will be presented as well as brief reflections of the consequences of such design.

1. INTRODUCTION

Studies of sensemaking in emergency response in major accidents and crisis have shown the importance of analysing the organisational and social processes affecting the actions of the involved actors (Weick, 1988, 1993). Major accidents and crises has been the primary focus for understanding sensemaking in emergency response but little attention has been paid to small- scale emergencies. A small-scale emergency could, if not dealt with adequately, quickly develop into a major crisis (Perrow, 1984). It is therefore advocated in this paper to focus on the sensemaking process in small-scale emergencies and specifically how a fire crew's sensemaking enroute to an incident is affected by limited and ambiguous information, potentially leading to undesirable results. This paper examines the sensemaking process of a fire crew enroute to an incident, using data from one emergency. Based on this, implications for design of information technology use to support sensemaking are suggested. The remainder of the paper is organized as follows. Section two briefly presents related research highlighting different approaches applied to study actors in emergency response. Section three presents the method applied in this study and describes in detail the data collection approach and associated problems. In section four sensemaking is

presented as the theoretical foundation and analytical lens. Following to this in section five the results based on the empirical data is presented and related to the theory of sensemaking. In section six the empirical findings are used to propose implications for re-design of the current information technology used by the fire and rescue services. The paper ends with a discussion in section seven and conclusions in section eight.

2. RELATED WORK

Studies of emergency response have a strong tradition to a focus on individual and team decision-making. Several studies have explored commander decision making in major incidents (Klein, Calderwood, Clinto-Cirocco, 1988; Burke, Hendry, 1997) using the *critical decision method*. The aim has been to understand decision-making in field settings and the method of doing this has been retrospective interviews. Studies of radio talk in large-scale emergency response exercises have focused on the effects of task-specific factors and situation specific factors on the communication pattern between key emergency management team members (Dunn, Lewandowsky, Kirsner, 2002). Studies of commander improvisation in emergency response (Mendoca & Berroggi 2001) have used field exercises to inform the design of decision support systems for field settings. Studies of

everyday work of fire crews and small-scale emergencies have not gained much attention. The limited attention could partly be explained by the time-consuming process of such studies.

3. METHOD

This paper reports from an ongoing extensive field study of every day work at communal fire and rescue services in Sweden. The field study has been conducted using an ethnographical approach (Hammersley & Atkinson, 1995) where approximately 700 hours of participant observations with fire crews has been conducted. Almost nine hours of video ethnography (Pink, 2002) has also been collected. Results from the field study will be used to inform the design of information technology use (Hughes, King, Rodden & Andersson, H. 1995) in operative fire and rescue services. The author has gained access to the fire crew and participated in the fire crew activities on both day and night shifts. When responding to alarms the author has used the mandatory protective clothing. Studying a group of people has presented some difficulties especially on alarms where the crew during enroute are distributed in two vehicles and the author have had his position on the second ladder vehicle, unable to observe the activities in the first rescue vehicle. In order to study the work practice in the first rescue vehicle during enroute, a video camera has been mounted on the dashboard pointing inward in the vehicle. The incident commander has started the video camera directly when he got seated. Field notes has in many cases been written down after the fire crew has left the incident site or back at the fire station.

The combination of field notes and video recordings have been used to triangulate the analysis. Using video data has provided a rich material otherwise difficult to collect and analyse on a micro-level. Transcribed field notes have provided material to analyse and understand the context.

The incident presented in this paper has been selected from a larger collection of observations and video recordings and is a good representation of a typical minor daily incident that constitutes the majority of alarms for fire crews in Sweden. However the specific events in this particular incident provide a good illustration of the typical difficulties confronted during enroute to an incident location and the actor's efforts to make sense of the situation.

4. THEORY

The theory of sensemaking is here applied as an analytical lens and is used to analyse the data and validate the findings. Sensemaking is based on the idea that "reality is an ongoing accomplishment that emerges from efforts to create order and make retrospective sense of what occurs." (Weick, 1993). According to Weick, sensemaking is not a metaphor but, as the making of sense. Sensemaking and interpretation are highly related concepts but not each others equivalents, "sensemaking is about the ways people generate what they interpret" (Weick 1995, p 13). Sensemaking is understood as a process, consisting of seven characteristics, that is; grounded in identity construction, retrospective, enactment of sensible environments, social, ongoing, focused on and the extraction of cues, driven by plausibility.

The task of the sensemaker is to convert experiences to something meaningful, and fundamentally establishing and maintaining his or her identity. Situations experienced by people are progressively clarified and this clarification emerges when people in retrospect brings the pieces together to create a sensible explanation of the situation. One can only make sense of something after it has been experienced. The time period from experience to the making of sense could be a split second or a rather prolonged period of time. When people act to make sense, they also affect the environment that they are trying to make sense of. This means that people act in a context and this context is shaped by people actions to make sense. When people make sense, it is not an isolated activity but continuously ongoing. Sensemaking is as a social process and part of people's daily social interaction where meaning are established in and influenced by the presence of collective social structures. The context in which sense making occurs affect what cues will be extracted and how these cues are interpreted as well as the revision of those interpretations based on following actions and their consequences. The making of sense is more oriented towards the plausible than the accurate due to the time criticality in many situations.

People are continuously making efforts to make sense of situations they experience and they do it by looking at a world upon which they already have imposed what they believe (Weick, 2001, p.15). In order for people to make sense, they must act. In sensemaking it is understood that action precedes understanding. People act in some form of social context involving a collective of people, which are affected by the actions or take part in these actions. "Sensemaking is focused on those actions around

which the strongest commitment forms” (Weick 2001, p.26). Commitment binds the individual to his behavior and influences the individual’s further sensemaking.

Committed action determines the scope of interpretation by focusing on those cues that suggest potential justification of that committed action. Commitment is an additive process resulting in a situation where new justifications and meanings slowly emerge due to their ground in old meanings that are to some degree persistent even if they are outdated.

This means that to make sense, people as actors in a social context will interact and make committed actions based on a cues that help them to justify their actions in that particular social context.

In situations characterized by ambiguity and unexpected events people’s efforts to make sense becomes visible for analysis. When a group of people are surprised or when they experience that expected events does not occur, people direct their conversation to clarify the blurred and confusing picture, i.e. to make sense. The analysis in this paper is focused on the conversation between the operator, incident commander and the fire crew where commitment, cues and justification affect the behavior of the fire crew.

5. RESULT

The setting reported from in this paper is a fire crew in a suburban district in a major city in Sweden. The fire crew consists of the incident commander (IC), the fire crew foreman and five firemen, making a total of eight people. In the incident examined here, the fire crew is dispatched by the command centre operator (CCO). The incident response is initiated when a person have called the national emergency organization and reported a fire in what is understood as an electrical power station. The command centre operator dispatches the fire crew, which initiates the drive to the incident location using rescue vehicle 411 and 413. Due to the vague location description by the caller, the CCO and IC face problems to determine the location. The CCO contacts the energy company. Information from the energy company influences the fire crew’s actions of the incident.

The data outlines the communication between the command centre operator (CCO), the incident commander (IC), the fire crew foreman and three firemen in rescue vehicle (411) and additional two firemen in the ladder vehicle (413). The

observations have been divided in two parts with subsequent detailed analysis.

5.1 Sequence A

This sequence shows how the involved actors are trying to understand and define the incident location and the type of incident. The sequence starts when the fire crew just has left the fire station and the IC establishes contact with the command centre.

#	Time	Actor	Conversation (Text in <i>italics</i> represents talk over radio)
01	0.00	IC:	<i>Four-eleven (411), one-one-three, we are heading for Nuevo-hotel</i>
02	0.05	CCO:	<i>Okay, four-eleven (411), behind Nuevo-hotel along the cycle way there is an electricity-house, says the caller, and there is smoke. You will have eighty-six adam. Over</i>
03	0.20	IC:	<i>eighty-six adam...what company or address did you say?</i>
04	0.31	Fireman:	<i>you have to decide yourself, John</i>
05	0.32	CCO:	<i>no...along the cycle way behind Nuevo-hotel, there is some...a large...an electricity-house...with smoke coming out...contact the energy-company to hear if they have something there</i>
06	0.36	Foreman:	<i>drive to the backside,....when you pass the OceanStore</i>
07	0.41	Driver (John)	<i>Okay</i>

08 0.50 IC: *Sounds good...and you take contact with the energy company*

09 0.54 CCO: *I'll do that, Andrew*

10 1.03 IC: I do not understand what company he is talking about...but...

11 1.07 Foreman: But we should drive behind the apartments...on the backside

12 1.20 IC: Yeah, there is that...that entrance gate

13 1.28 IC: It will be goblin steps

14 1.30 Fireman: Yes

15 1.38 IC: If there is ground current you should not take any big steps
[laugh]

5.1.1 Sensemaking triggered by ambiguity

The location of the incident is vaguely described by the caller making it difficult for the CCO to provide a distinct location to the IC. In parallel to the CCO and IC conversation, the foreman gives route directions to the driver of the rescue vehicle based on ambiguous information. The ambiguity of the information is highlighted by the IC's response to the CCO requesting a company name or street address, which is the standard method to define an incident location. The reaction from the CCO is an accentuation and repetition of the prior information. The CCO is at this moment in a troublesome position where he is unable to comply with the IC's request to deliver an adequate incident position. A solution is immediately formed by the CCO when telling the IC that contact will be taken with the energy company, to find out if they have something in the area. The IC supports this action and confirms that the CCO shall make the contact.

The sensemaking triggering event is visible in line 03, when the IC requests company name or address. Having no street address or company name, but rather a vaguely described geographical location, violates what the IC in this situation normally expects.

The conversation (line 05,08,09) shows how the interaction between the IC and CCO results in a commitment, a commitment to take contact with the energy company. Further, this commitment binds the CCO to this agreed action by the IC's explicit public

and irrevocable remark that the CCO shall make the contact. The interpretation of this is that the CCO not only shall make the action but also is responsible for that action. As will be shown later, this commitment will have implications on the following actions presented in sequence B.

5.1.2 Defining the location using reference points

When the conversation with the CCO ends, the IC turns to the foreman and fire crew in the back seat compartment, expressing that he does not understand which company the CCO refers to. The interpretation of this is that the IC has a company as a reference point different to "behind Nuevo-hotel" and "along the cycle-way" being the compound reference point for the CCO.

The foreman expresses his understanding of the plausible location and describes where they should proceed, without mentioning a company as a reference point but instead a selection of buildings. The IC responds and adds to this picture by mentioning the existence of an entrance gate corresponding to the location presented by the foreman. What is shown here is how the IC and the foreman uses their knowledge about the area and based on each others descriptions extract cues to build a shared understanding. In this particular case, the IC changes reference point from an undefined company to a very detailed reference point consisting of a gate in the local area. Interesting to notice here is that neither the IC nor the foreman explicitly makes any references to the term "electricity house", which based on the CCO information should be the object of attention. This could be explained by the simple fact that an electricity house is not part of the IC's or the foreman's area knowledge and therefore nonrelevant information at this moment.

5.1.3 Describing type of incident

In the opening conversation (line 02), the CCO describes the type of incident by saying "electricity-house" and "there is smoke" and declaring that this is information provided by the caller. The explicit reference that the information is what *the caller* has expressed implies that this information could be unreliable. In the conversation (line 05), following the IC's question regarding company or address, the CCO adds the description "there is some...a large..an electricity house...with smoke coming out". The term "electricity house" indicates that this incident concerns a fire in an electrical power station.

However, the hesitation in the CCO’s description of the constitution of the building makes an indication that this information is potentially uncertain. But, the joke made by the IC (line 13) referring to potential dangers with ground current shows that the IC has to some extent framed his understanding of the incident type.

The analysis of the IC’s conversation about the incident suggests a serial sequence where the object of attention is determined by urgency and plausibility. In this incident the urgency concerns the understanding of the location position. Without a satisfying understanding on the location, everything else will become less important. The location description is as previously mentioned, flawed by ambiguity, attributed several meanings. This means that the fire crew could risk ending up at the wrong location, which would extend the time for the fire crew to make the actual response. Focus is therefore on the issue of ambiguity of the location information.

The incident type is plausible, a fire in an electricity house, even if this information is flawed by uncertainty. This uncertainty could be minimized if or when additional calls are made by people on the location or by the fire crew themselves when they arrive to the accident location. This means that it is more important to determine the correct location rather than establishing an understanding what will face the fire crew up on arrival. The fire crew will be able to respond to almost any incident but this requires them to know where to go.

5.2 Sequence B

This sequence shows have the information obtained in the contact with the energy company affects the actions of the fire crew.

#	Time	Actor	Conversation (Text in <i>italics</i> represents talk over radio)
16	2.31	CCO:	<i>411 to, 400 over</i>
17	2.35	IC:	<i>411 responds</i>
18	2.37	CCO:	<i>I have talked to the energy company, it is the case that they have an electrical power station on the backside at Jellyfishstreet behind Nuevo-hotel and he will send a guy, over</i>
19	2.51	IC:	<i>That’s great, then I</i>

20	2.53	CCO:	<i>will know, over That’s acknowledged, over and out</i>
21	2.58	IC:	Did you hear that a guy from the energy company is also on his way
22	3.02	Foreman:	Electrical power station, or?
23	3.04	IC:	Yes
...			
24	3.17	Driver:	Should go...could come that way too, thought if you drove round there and in there
25	3.22	IC:	yes...
26	3.23	IC:	Think we shall do that
27	3.24	Driver:	Yes it feels so
28	3.25	IC:	Enter Jellyfish street instead
29	3.26	Driver:	Yes, it feels more [right]
30	3.27	IC:	We’ll do that
31	3.31	IC:	<i>413, we enter at Jellyfish street</i>
32	3.35	413:	<i>That’s acknowledged</i>

5.2.1 Emerging information

Two minutes after the initial conversation the CCO calls for the IC’s attention informing the he has talked to the energy company and that they have an electrical power station on Jellyfish Street behind Nuevo-hotel.

The CCO also informs the IC that the energy company is sending a person to the location. In this conversation the CCO have switched terminology from “electricity-house” to “electrical power station”. The IC does not comment the shift of terminology but responds to the new information with the general expression “that’s great, then I will know”.

Immediately after, the IC turns to the firemen and foreman in the backseat compartment and says in a question-like phrase if they heard that the energy company sent a guy. The response by the foreman is a new question “electrical power station, or?” to which the answer from the IC is “yes”. What is shown here is a committing act where the IC and foreman socially defined the incident type as a fire

in an electrical power station. This committing act defines the context and has effects on following actions.

Moments before the rescue vehicle (411) approaches a road intersection the driver suggests an alteration (line 24) of the approach route to better correspond to the newly established understanding that Jellyfish Street is the incident location. The conversation between the driver and the IC about alteration of route show how they construct justification for this route alteration. Prior to the contact with the energy company, Jellyfish Street was never discussed. In sequence A, the IC and foreman agreed on a different accident location. It could therefore be stated that the alteration of the route choice is a result of the information obtained from the energy company and a justification of the previous committed act by the IC and foreman defining the type of incident. As a consequence the route choice is altered in order to align with the socially defined understanding of a fire in an electrical power station at Jellyfish street.

5.2.2 Preferential right of interpretation

What is evident in sequence B is how the fire crew and specifically the IC and foreman and not the CCO, have the preferential right of interpretation. The CCO did not express that the incident concerned a fire in an electrical-power station at Jellyfish Street. However, the committed actions of the CCO, IC and foreman created the environment where this became the only sensible direction. The preferential right of interpretation is not explicitly expressed in the fire and rescue service organization procedures but becomes visible in the actions of the fire crew.

5.3 Epilogue

Further but not part of the scope of this paper, when the fire crew arrives to the perceived location they are unable to use the desired approach route forcing the IC to walk to the building and the driver to choose an alternative approach route. In retrospect it was shown that this incident did not involve a fire in an electrical power station, but a person having started a fire in his fire stove in a garage. The fire crew were not at the location of the electrical power station.

The analysis reveals how the initial and vague information influenced the actors following actions and understanding of the situation. In the chain of interaction it is evident that commitment binds the actors to their actions. Once contact was made with the energy company it became severely hard to

ignore the received information. The information flow was suffering of a filtering effect where the IC had to rely on second hand information, becoming third hand information when it reached the fire crew. All information delivered from the CCO was obtained in conversations with external actors; the caller, and the person at the energy company. The filtering effect of the information in this communication chain and the inability of the IC to ask further questions to these actors could partly explain the result of the sense making efforts. Only one information channel delivered information. The lack of other complementary information channels or resources restricted the fire crew's ability to validate and finding inconsistencies.

The analysis reveals how committed action creates the context for sensemaking by narrowing the actors' focus to a subset of cues in the available information that suggest reasonable justification of those actions.

6. DESIGN IMPLICATIONS

As presented in the previous section communication between the incident commander and the command centre is challenging and has potential to be improved. Therefore, in this section a set of implications for re-design of current technology use will be presented. The findings presented in the previous section will be linked to a set of suggested functionality aiming to provide improved support for fire crew sensemaking enroute to an incident. Based on the analysis, two fundamental issues are derived, namely the two issues; knowing where and knowing what.

First, *knowing where* focus on understanding and defining the location of an incident. As presented in the result section, situation specific aspects concerning the alarm have the potential to restrict the fire crew's ability to determine the incident location. Information received along the road might influence alteration to the intended approach route.

Second, *knowing what* focus on understanding and defining the type of incident. The findings in this paper show that this issue is secondary and less important compared to knowing where. However when the knowing where issue is solved the issue of knowing what becomes primary. These two issues will be further elaborated and specific functionality will be proposed in order to support and improve the related work practice.

Knowing where

Fundamental functionality to improve a fire crew's enroute incident sensemaking involves

support for a common and mutual representation of the perceived incident location. As shown in section 5.1.1 and 5.1.2 the actors face problems when using different reference points for establishing an understanding of the location. Providing support for mutual representation would result in a situation where the IC and CCO have the same type of information at hand when trying to making sense of an incident. The common representation should include not only street names but contextual information of buildings and descriptive information regarding the various businesses in the buildings. Contextual information could also include information from sensory systems such as fire alarms and property surveillance cameras.

In the time-critical work of getting to the incident location, voluminous information must be avoided. Instead the design must provide rich information without increasing the complexity. A mutual representation using contextual information would extend the range of possible cues for the sensemaking process, making the fire crew more capable to find inconsistencies in portions of the delivered incident information. Having access to mutual representation of the location have the potential to better support the practice of using reference points, as reported of in section 5.1.2, to make sense of the incident specifically when the incident is subjected to ambiguity as reported of in section 5.1.1.

Knowing what

As presented in the section 5.2.1, during enroute the CCO in some cases make external contacts to find additional information regarding a particular incident. This includes contact with various professional organizations in the society but also re-establishing contact with the caller of the specific alarm. Participating in such conversations could be of importance for the IC's understanding of the incident. Further, due to the IC's preferential right of interpretation (section 5.2.2), having access to first-hand information is fundamental and would limit the information filtering effect.

Support should therefore be provided to enable the IC to listen-in to the CCO's conversation with other actors concerning the specific incident. This does not however imply that the IC should handle the administrative efforts to establish such contacts nor forced to having a dialogue, but rather an ability to listen-in and the possibility to ask additional questions when necessary. As reported in section 5.2.1, information is emerging over time as the situation is unfolding. Listen-in support is central in order to coordinate the efforts of the IC, CCO and external actors to make sense of the specific incident. Being able to listen-in to conversations,

especially in situations of ambiguity, could improve the IC's ability to establish a broader understanding of the location and the incident type based on a richer set of cues.

In this section, functionality to improve sensemaking has been proposed targeting the core issues of *knowing where* and *knowing what*. A fundamental aspect of the proposed functionality is its ability not only to provide better support for the IC and fire crew but to improve the collaborative work between the CCO and the IC. The proposed functionality does not aim to disconnect the fire crew from the command centre but instead bring the two units closer together. Designing information technology as proposed above have the potential to focus the conversation between the CCO and the IC on the available information instead of spending valuable time to deliver the information by voice. This means that these two actors could have more time to make sense of the information. Providing information technology to the fire crew will not only have consequences for the fire crew but for components in the emergency management system. Therefore, it is important that the design of this technology is done with the ultimate goal to improve the fire crew's ability to make a rapid, efficient and safe response.

7. DISCUSSION

This section offers a discussion of the method, theory, the suggested implications for design and consequences of such design.

Studying a group of mobile people that are geographically distributed, and the sorts of technologies they use or might have use for can from a methodology perspective be challenging (Weilenmann, 2003). In this paper video recording and observation has been the primary data collection methods. The video data was used for two purposes. Firstly, to study the radio communication between the IC and the command centre. Secondly, to study the conversation and actions in the rescue vehicle (411), a setting difficult to study using direct observation. Observation was also used to study the actions of the fire crew on the incident location. The researcher was not sitting in the rescue vehicle (411), where all the communication took place, but positioned on the ladder vehicle (413) also dispatched to the incident. Being unable to do direct observations in the rescue vehicle (411) and only rely on video data has its shortcoming. However, the phenomena under study were sensemaking, an activity typically visible in conversations. The

conversation over radio and in rescue vehicle (411) was captured on the video recording. The dual use of data collection methods has provided complementary data for the analysis. Observation has provided contextual data and general understanding of the work domain whereas the video data has provided means to perform micro analysis of the work practice. The observations provided the fundament for the narrow and detailed study of the video data (Heath, C. & Hindmarsh, J. 2002). The specific incident was selected from a collection of incidents and the purpose was to show how a fire crew is making sense of an incident during enroute.

The theory of sensemaking was applied as an analytical lens showing how initial and vague information influences the actors following actions and understanding of the situation. In the chain of interaction it was evident that commitment binds the actors to their actions. Further the findings show how committed actions and their consequences are complicated to reverse.

The design implications was derived from the data suggesting functionality to improving the sensemaking process by supporting the issues of *knowing where* and *knowing what*. The suggested functionality aims to provide richer information and listen-in support that improve the collaboration support between the IC, fire crew and the command centre. These design implications have consequences for the organization both on a technical level and on a role level. The consequences on a technical level involve a re-design of the information technology and systems of the fire and rescue services. Portions of the geographical information systems currently existing only at the command centre must be deployed in rescue vehicle setting. Additional data sources partly providing the contextual information requires the fire and rescue services to provide interfaces for external providers of sensory data. The voice-communication infrastructure must provide transparent access to a variety of communication channels such as radio-, mobile phone-, and fixed telephone-traffic.

The organizational consequences with improved collaborative support will have consequences on role specific tasks. Providing the fire crew access to incident information during enroute will change their relation to the IC currently mediating such information. The hierarchical chain-of-command has to be adapted to the suggested changes in how information is delivered. Over time the work in the command centre could due to information technology improvements potentially change from a command and control function to resemble more to an information broker service. Understanding that the preferential right of interpretation in this practice resides on the operative fire crew and not the CCO

as the centralized coordinator opens up questions regarding how time critical information should be retrieved and delivered. Further, the role of the coordinator and the organizational position and mandate for this role is not unproblematic. Changing the roles and work practice will not be done in short time nor is it an objective. But changes in information technology will inevitably also affect the structures in the command centre and the CCO role in providing support to IC.

8. CONCLUSIONS

In this paper an analysis of sensemaking in a fire crew enroute to an incident has been presented based on the theory of sensemaking. Empirical data from one incident has been analyzed in detail resulting in implications for design. These implications consist of functionality to support the use of contextual information, direct access to first hand information, and improved collaborative functionality between the command centre operators and the fire crew. The consequences of the suggested information technology improvements have been briefly elaborated. However, what the exact consequences will be and the effect it will have on structure, roles, and responsibilities are severely hard to foresee. Therefore, all information technology design in this domain must be done with reflection and be driven by a clear objective to enhance the ability of the actors and not driven from a technology perspective.

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