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EMERGENCY MANAGEMENT PERFORMANCE, THE IMPORTANCE OF ON-SCENE DECISION MAKING

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Abstract

An effective emergency management is often connected with the goals achieved in the response activities. However, it is not clear which subsequent factors contribute to whether the emergency management should be regarded as a success or not. One factor, the on-scene commanding structure, and the on-scene commander in particular, plays an important role in fighting emerging crises. Dynamic decision making at the "sharp end" presents severe requirements to the commanders. This paper reviews research in the area of on-scene commanding, with special attention being paid to models developed to illustrate decision making under uncertainty in emergencies. The Norwegian practices on emergency response and rescue operations, at regional and local levels, are taken into account. The paper discusses the applicability of the models, this based on 20 years of experience as the commanding officer of a Norwegian fire department. Research in the area of real-time emergency management is difficult from a methodological point of view, due to sudden scenario occurrences, the vast number of variables involved, and the apparent uniqueness of each scenario. Finally, some ideas on future research designs applied to real-time emergency management are presented.

Introduction

Disasters, crises, accidents and incidents can strike at anytime and anywhere. Emergencies take many forms: a hurricane, an earthquake, a fire, a hazardous spill or a terrorist attack. They can be acts of nature or acts of man. The emergency can develop over days or weeks, or it hits suddenly, without warning. The consequences vary from purely local damages, to impacts on regional areas, through to national or even multi-national consequences. Every year, millions of people face disasters, and their terrifying consequences.

Decisions made now and in the past impact on the risk picture and can influence the occurrence of future emergencies. Figure 1 is an illustration of the different decision domains, where the horizontal axis shows the distance from the accident location, and the vertical axis shows the level of authority.

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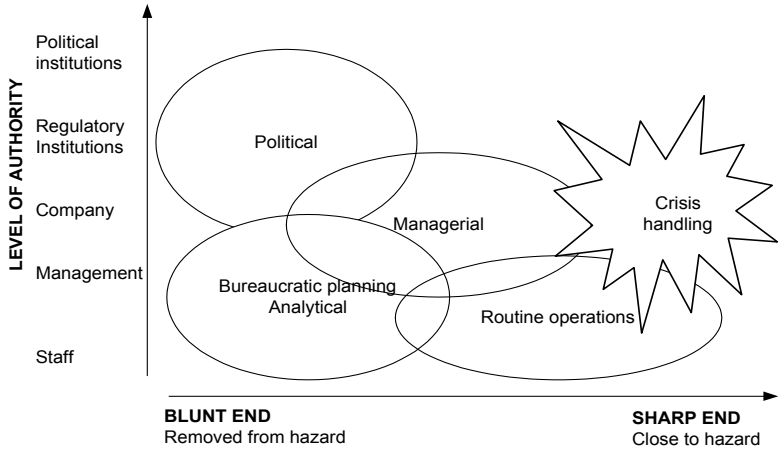
Figure 1: Typology of decision making settings, Kørte, Aven and Rosness (2002)



This paper deals with leadership at the sharp end, the crisis handling. That is the decision making in action, at the accident scene. Typical decision makers on-scene are the commanding police officer at the riverside close to the collapsing bridge, the captain on board a sinking ship and the fire chief outside the burning hotel. Decisions when a crisis is in progress are made on many different levels, but in this paper the focus is limited to the decision maker who has the overall responsibility on-scene during the crisis.

The remainder of this paper is organised with firstly, a presentation of the Norwegian model of disaster management. Secondly, a review of existing research focusing on both taxonomies and models of decision making on-scene. Thirdly, the models are discussed with reference to the Norwegian on-scene commanding structure. The paper concludes with some ideas for future action research based on my own experiences as a fire chief.

The Norwegian model

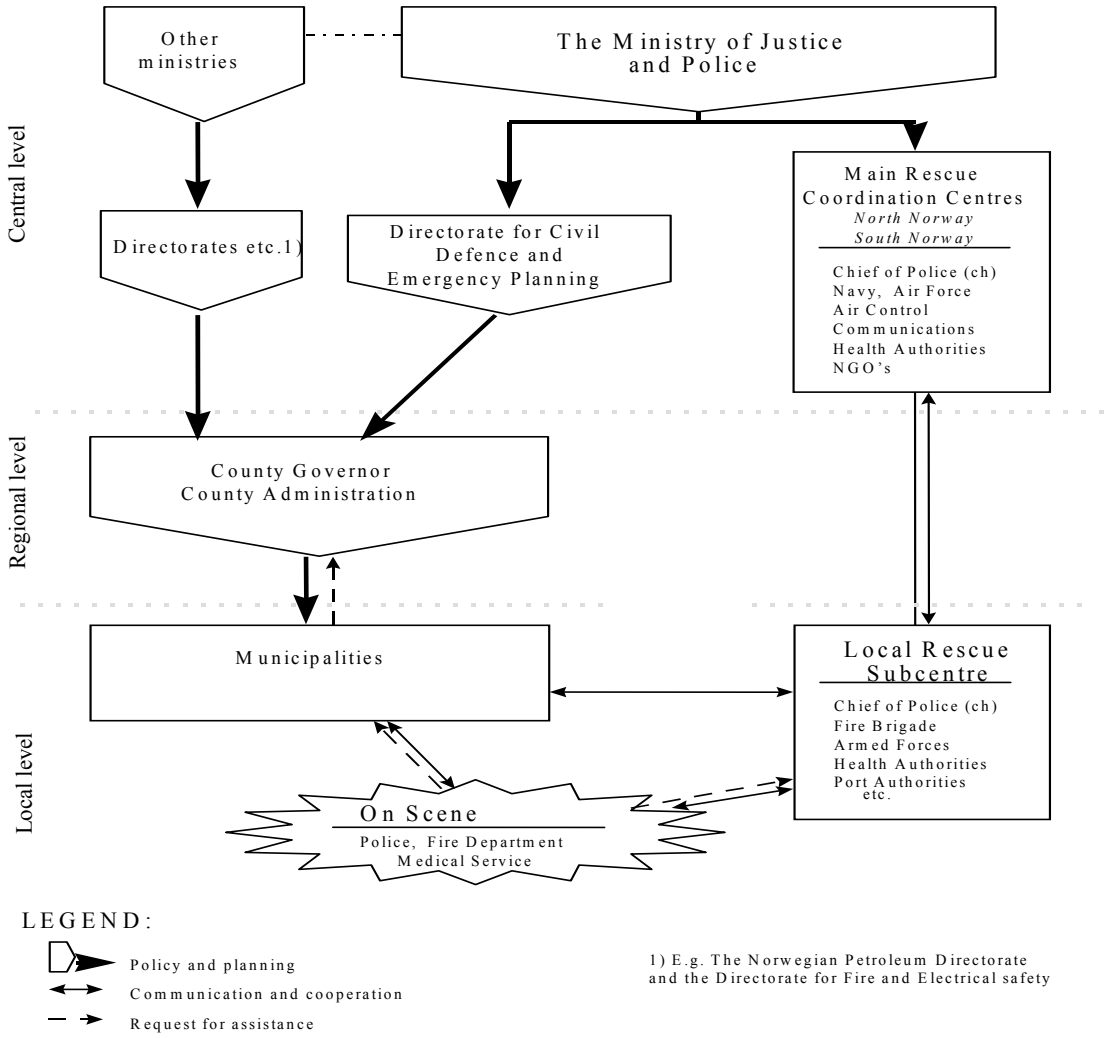
Norway measures roughly 155,000 square miles; the country is long, narrow, mountainous and is deeply intended with many fjords. Off the 25 148 km long coastline, (which is twice around the equator), 64 oilfields produce annually 181 mill. SM^3 oil and 53 bill. SM^3 gas (Norwegian Petroleum Directorate, 2002). The population of Norway, 4.5 mill., reside mostly in urban areas. Avalanches, hurricanes, floods, accidents in the petroleum activity, transport accidents (air, railway, sea and road) and fires are typical examples of Norwegian emergencies. Norway has 276 km of train tunnels and 638 km of road tunnels. The longest tunnel is the Laerdal tunnel, 24.5 km. To date, tunnel incidents have been a minor problem.

What is the Norwegian model for disaster management? Well, a general model is difficult to ascertain. Fragmented and decentralised responsibilities are the most prominent characteristics of the Norwegian model. However the Ministry of Justice and Police, cf. Figure 2, play an important role, and its responsibility will probably increase in the future national emergency management organisation. The government proposed in April 2002 to gather the public safety (security and emergency planning) in one directorate (The Ministry of Justice, 2002).

On the preparatory side of the emergency management, there has been a shift into risk based regulations. The Directorate for Civil Defence and Emergency Planning (DCDEP) has been a pioneer, by issuing guidelines (e.g. risk and vulnerability analysis, emergency planning, crisis management), by promoting emergency training and by performing surveillance of the municipalities' planning processes.

Figure 2: The Norwegian model on Disaster Management

DISASTER MANGEMENT IN NORWAY



The local and regional response and rescue service is a co-operation between the local police, the fire service and the medical service, in which the police have the co-ordinating responsibility. A typical local rescue team in an average Norwegian municipality (8.000 to 20.000 inhabitants) consist of; the local sheriff and his deputies, 16 part-time fire men and a local ambulance service. The train accident on the Røros line January 4th 2000 killed 19 persons (NOU 2000: 30). The local rescue service, as described above, stood alone fighting the crisis more than 30 minutes before additional resources of any consequence arrived. The problems with the Norwegian model are related to long distances to the neighbouring rescue services. They are expected to cope with wide range of challenges/scenarios, they have limited rescue competence (experience and knowledge), and work with limited resources. The available rescuers (firemen and paramedics) are often engaged on a part-time basis. In addition, the position of local commander is often seen as a solitary responsibility. The major problem with the fragmented responsibility model in Norway is

that, in response to major accidents, it takes an unnecessarily long time to establish an on-scene emergency management team.

My responsibility as fire chief in Sandnes and 3 neighbouring municipalities, is 100 000 inhabitants, 8 fire stations and 170 employees, where 110 are part time. In a normal year we have to deal with almost 100 building fires (minor and major), 30 traffic accidents, 20 hazardous materials responses and 1500 paramedic responses. The fire chief is the on-scene commander (in fires, traffic accidents, train crashes, etc.) until the arrival of the local police.

Emergency management and on-scene decision making - taxonomy

Traditionally research has been focused on the general managerial/organisational decision making and the political decision making during emergencies (e.g. 't Hart 1998, 2001; Rosenthal et. al. 1989). Decision making under uncertainty and under time stress are general characteristics that could be related to an accident scene. The command system on-scene, surprisingly, seems to have engendered little attention amongst researchers. Some work has been done within military defence (Verzberger, 1998) and the fire and rescue service (Klein 1993). These contributions have mainly been theoretical. Applied research is almost absent. So far no scientific documentation has been found on successful on-scene management, i.e. why things went well. Of course, many inquiries/investigations have been carried out and they have given valuable knowledge about what went wrong, why the accidents occurred and whom to blame. However, in the same investigations, evaluations of the actual rescue operations in the sharp end have generally been but superficially performed.

Emergency management

Emergency management is the process of preparing for, mitigating, responding to and recovering (or reconstruction) from an emergency (FEMA 2002; 't Hart, 2001; Roshental et al., 1989). This seems to be a common interpretation in the research literature. But this definition also relates to terms like *risk management*, *safety management* and even *crisis management*. Are these different? Is it arbitrary which term to use or are they mutually exclusive? A massive amount of research literature on the different topics exists, and our conclusion is that the differences are more related to the research environments and traditions, than to specific physical, organisational or operational factors. Intuitively, the severity and the time constraints of the event, and the potential outcome could be used to separate the terms. No one seems to have challenged the use of terms, and what effects the uses on these terms have had.

Emergency management is a dynamic process, the work domain changes for each task. Each scenario is unique and its circumstances are often badly structured and, consequently, will only in broad general features be known to the combating actors. The teams involved are not static; they change from time to time, as the commander (Rasmussen et al. 1991) does.

Crisis

The Federal Emergency Management Agency (FEMA) quotes "an emergency is unplanned events that can cause death and significant injuries…". Other terms are accident, crisis, and disaster. Many describe crisis as borderless threats, creeping and acute (urgency), contending reality claims (uncertainty/surprise), ongoing process (compressed decision – making), conflictual and media roaming free ('t Hart 2001). Rosenthal et al. (1989) uses the "un-ness" to characterise the disasters; unpleasant, unexpected, unscheduled, unprecedented and almost unmanageable events. The National Center for Crisis Management Research and Training of the Swedish National Defence College in Stockholm (Olsson 2000), define crisis as an event consisting of the three criteria; important values are at stake, limited time to deal with the situation, and a great deal of uncertainty

involved. Thus, it can be concluded that decision making on-scene must include the terms: *severe threats*, *uncertainty* and *prompt action*.

On-scene decision making (commanding)

"We do not make decisions, we fight fires!" (Klein 1989), is a typical response from the fire chief to the inquiry about what decisions were made during a building fire. This indicates that the process leading to the different decisions is an automatic process.

Decision making in the on-scene context, has in the research literature many different names, such as decision making in action (Klein, 1993), rapid decision making (Klein, 1993), dynamic decision making (Brehmer, 1992), decision making in natural context (Rasmussen, 1991), vigilante decision making (Janis and Mann, 1977), naturalistic decision making (Klein 1993) and crisis decision making (Rosenthal et. al, 1989). Dynamic decision making may often be a compromise between a good strategy for controlling the decision task, and a strategy that enables the decision maker to exert some measure of control of the rate at which he/she has to make decisions (Brehmer 1992).

Edwards (1962) gives some characteristics of dynamic decision making. Firstly, *a series of decisions is required to reach the goal*, a successful outcome. Secondly, *the decisions are not independent*. One decision leads to a later decision. Thirdly, *the state of the decision problem changes*, both autonomously and as a consequence of the decisions already made. Brehmer (1992) adds a fourth characteristic; *the decision has to be made in real-time*, which means that the decision maker is not free to make decisions when he himself wants to. He/she cannot wait until he/she has gathered all the information, made the analysis and organised the necessary resources. The decisions must be made in accordance with the demands of the situation. The decision maker is the "owner of the problem "; no one else can make the decision. We can describe the decision process as a longitudinal time process. Time is running, and it is impossible to stop or have a time-out. In addition, the goal of a successful outcome is not straightforward in a crisis. The decision making is often incremental, in which it is difficult to relate sub goals to the ultimate one. This is emphasised by Klein, Orasanu, Calderwood and Zsambok (1993), who describe the conditions of on-scene command with ill-defined goals and ill-structured tasks. They also introduce the notion "knowledgeable people", which means that every crisis consists of a unique combination of knowledge from both the rescuers and the victims. In order to cope with the event, the on-scene commander has to perceive the real-time situation and its dynamics. Orasanu and Connoly (1993) introduce ideas of a commanding strategy on-scene, employing feed-back loops, and Brehmer (1992) adds feed-forward strategies to deal with the changing situation in real-time. The workload on the on-scene commander can be extreme, compounded by; the *critical values at stake*, *multiple players involved*, *time constraints* and *competing goals* (Orsanu and Conolly, 1993). The decisions that are made in the first minutes, and hours, are crucial to the successful mitigation and the overall conclusion of the crisis (Kowalski and Vaught, 2001). An on-scene commander is essential, especially when the crisis is novel, the consequences are unclear, different authorities are involved, many actors struggle on-scene and the media are paying particular attention.

Uncertainty is regarded as a prominent characteristic of on-scene decision making. Hansson (1996) presents interesting considerations concerning severe uncertainty, i.e. in cases where "the decision maker lacks much of the information that is taken for granted in the textbook cases". Although Hansson's ideas are not related to emergencies, important parallels effects can be discerned. The uncertainties relate to: the identity of the options not being well determined (*uncertainty of demarcation*), the consequences of at least some options are unknown (*uncertainty of consequences*), it is not clear whether information obtained from others, such as experts and informants, can be relied upon (*uncertainty of reliance*), and the values relevant for the decision are not determined with sufficient precision (*uncertainty of values*). The main common characteristic

of on-scene commanding and decision making is uncertainty. Uncertainty is the on-scene commander's sword of Damocles.

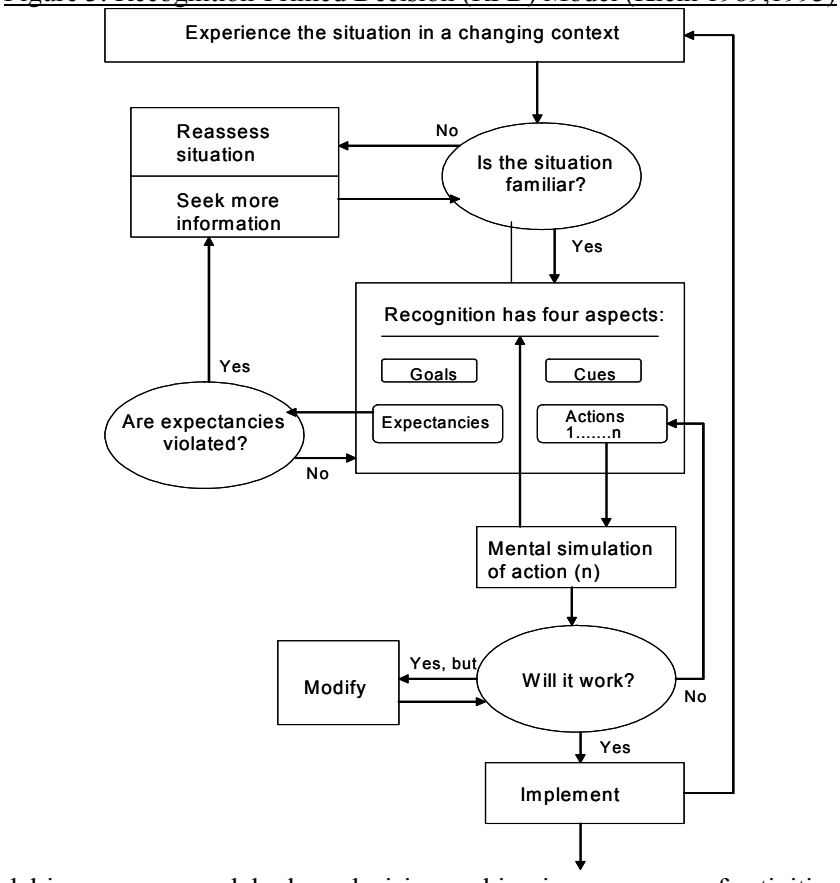
Emergency management and on-scene decision making - models

Human decision making might be thought of as a process where individuals construct certain maps to help to clarify their thoughts and subsequent actions. The map summarises the interdependence of variables, or the influence that one variable might have on another. We define the map as a model.

The following presentation is not an exhaustive overview of models employed in or developed from on-scene decision making.

Recognition-Primed Decision (RPD) Model (Klein 1989,1993) refer to Figure 3, is selected as a starting point, because intuitively it complies with my experiences as a commanding officer.

Figure 3: Recognition-Primed Decision (RPD) Model (Klein 1989,1993)

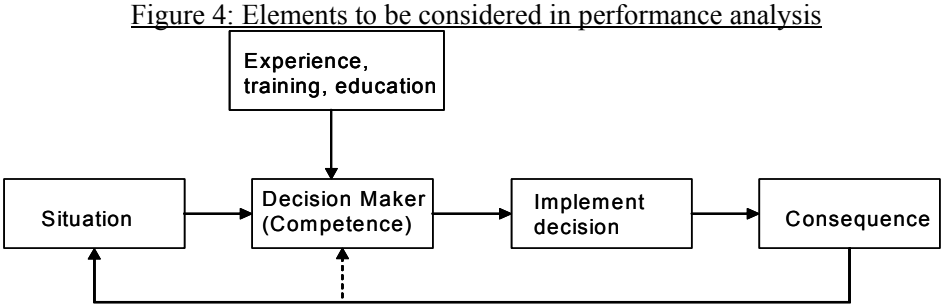


The RPD model is a process model where decision making is a sequence of activities. The process consists of three typical phases; *Situation recognition*, *Serial option evaluation*, and *Mental simulation*. Klein's conclusion is that proficient or expert decision makers rarely compare among alternatives. Instead they assess the essence of the situation, e.g. types of building fire and its demands. Then they select an action which they know will cope with the urgent situation, e.g. use a ladder and smoke divers to rescue the people trapped on the third floor of the burning house. This view on the mental reasoning of experts is also supported by Cosgrave (1996).

The RPD model describes emergency situations, minor as well as major, offshore and onshore, earthquake and landslides, and that is its forte. In addition it is easy to understand and it is holistic. The decision maker identifies critical cues (e.g. is the driver breathing after a car crash?), then one assesses the situation (the driver is not breathing), and implements action (CPR, cardiopulmonary resuscitation). Plausible goals are set (the non-breathing driver should be able to breathe on his own). The action is evaluated (is he breathing?). If the patient does not breathe, the decision maker has to start the process over again. The RPD model includes feedback loops (e.g. the effect of the actions that have been carried out) and mental simulations promote feed forward loops - a way of being proactive.

The decision problem on scene can be compared to a model from cognitive psychology where focus is placed upon the person's ability to meet emergency situations in a functional way. This implies that the decision maker needs to know in *which situations* he/she must act, the decision maker must be *familiar with* his/her tasks, the decision maker must be *able to perform* his/her tasks in an appropriate way and be able to *evaluate the consequences* of his/her own commands. Schematically it could be presented as follows:

Figure 4: Elements to be considered in performance analysis

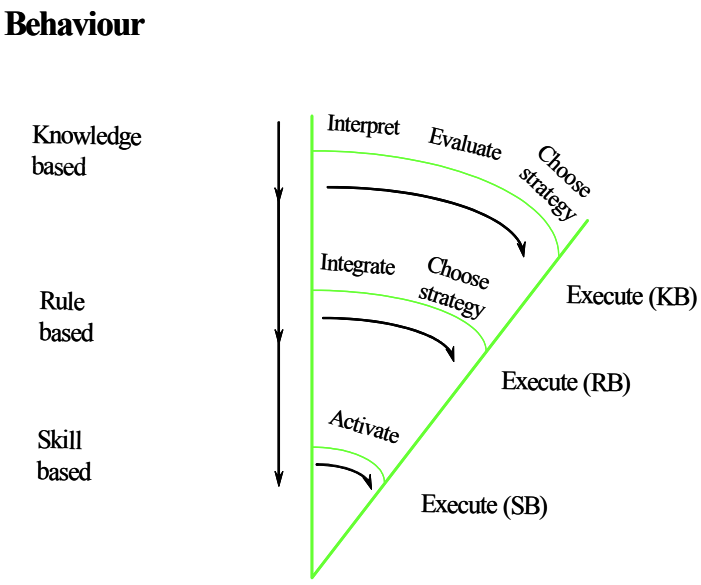


If a *situation* should occur, for instance a fire, a *Decision Maker* should - as a result of experience, training and education - be capable of evaluating the fire situation from, for example, an evaluation of the smoke plume and/or information from the personnel. He/she shall *react/implement his/her decision* in an appropriate manner, for example command smoke divers to a specific entrance. Finally he must be able to evaluate the *consequences* of his own commands, for example by checking that chosen fire fighting method has been effective. All elements are critical for the aim of achieving an effective emergency response. But what kind of competence is then needed? Rasmussen's (1982) behaviour model could be applied:

One problem with crises is that they can not be deterministic described in advance, because they have a stochastic nature. Thus it is not usually sensible to train decision makers for certain behaviour in a specific scenario and well known environment. The decision maker's competence should be balanced in a way that he/she both is able to analyse the situation (knowledge based level) and able to respond quickly and automatically (skill based level).

An offshore installation manager (OIM) will usually become the head of the rescue management in an accident situation. In these situations the OIM is responsible for the strategic decisions. The OIM must be able to analyse the situations and find/extract effective solutions. His/her behaviour is primarily knowledge based, but as a result of effective training, parts of the behaviour could be shifted to rule based and even some to skill based level. The OIM could be trained to recognise situations and connect them to established procedures for actions to be taken. Training could improve the decision making behaviour, ref. fig. 5, both the decision maker's ability to generalise (vertical arrows) and his/ her ability to discriminate (curved arrows) between events (Njaa, 1998).

Figure 5: Training impact on behaviour level and thus decision making on-scene (Njaa, 1998)



Lipshitz (1993) reviews and compares nine models of decision making, including the RPD model. Lipshitz identifies six common features; Real-world decisions are made in a variety of ways, Situation assessment is a critical element in decision making, Decision makers often use mental imagination, Understanding the context surrounding the decision process is essential, Decision making is dynamic – it does not consist of discrete isolated events or processes, Normative models of decision making must derive from an analysis of how decision makers actually function, not how they ought to function.

Lipshitz's (1993) Argument–driven model suggests that consequential choice, matching and reassessment are three generic modes of making decisions. Especially interesting is his description of consequential choice, which is framed as forward-looking choices. The expression ”think ahead” advocates a proactive management, which, in my opinion, is crucial to success.

Applicability of research achievements to a Norwegian fire and rescue service

Is research useful in the practical setting that constitutes our daily work? So far, I am not sure. The models are developed by researchers with limited experience in practical emergency management and decision making. Many of the models are abstract, incomplete and lack practical perspectives. Descriptive models clarify to some extent important features seen in emergency management, such as decision makers' challenges and attitudes. A question is, how can these models be integrated into the sharp end of decision making? Of course, the material could be used in training and theoretical education as an informative background. However, the *normative models* – the ideas of how activities and decisions *should* be made - are scarcely discussed. If we cannot say anything about what is constructively good and bad practice, the work has rather limited value.

Dreyfuss and Dreyfuss (1986) present the competence stages from *novice*, through to *advanced beginner*, to *competent performer*, to *proficient performer* and finally to the *expert*. As Klein (1993), Orsanu and Conolly (1993) and Cosgrave (1996), Dreyfuss and Dreyfuss claim that an expert generally knows what needs to be done based on mature and practised understanding. An expert's skill has become so much a part of him that he does not need to be more aware of it than he/she is of his/her own body. When things are proceeding normally, experts are not actively solving problems or making decisions, they are intuitively doing what normally works. Whilst most

expert performance is ongoing and non-reflective, when time permits and outcomes are crucial, an expert will deliberate before acting. This deliberation does not require calculative problem solving, but rather involves critically reflecting on one's intuition. But, being able to describe an expert does not help. How do we develop on-scene commanders from being novices to becoming experts? Must they learn the hard way?

Decision quality is discussed by Simon (1955). Simon claims that people satisfy rather than maximise when they make decisions. To satisfy is to choose a path that satisfies your most important needs, even though the choice may not be ideal or optimal. This statement complies with the characteristics of decisions in emergency response. The reason is obvious; there is not sufficient time to optimise. One simply chooses the best option available.

Normative models, based on a comprehensive set of success factors, could be a good starting point for increasing the competence levels amongst on-scene commanders. The objective is to aid the decision maker under stress to make sufficient decisions at the right time, and to help implement the decisions. Remember, in Norway many on-scene commanders are infrequently in action, and rarely do they experience major accidents. From my experience, work to develop a set of success factors should be based on:

- A wide range of situations, e.g. from small traffic accidents to regional floods
- Mental maps for information seeking, evaluation and problem solving – recommended heuristics. Assessment of the situation and information processing
- Capacity of equipment and resources
- Inter-human relations and trust
- Level of uncertainty
- Time constraints and conditions that increase time stress in the situation
- Establish major goal and sub goals
- Ability to change courses of action

Brehmer (1992) emphasises that the proficient or successful on-scene commander often collects more information, he/she collects it more systematically, he/she establishes adequate goals, he/she evaluates the effects of his/her decisions and he/she is generally more systematic in their work. Orsanu and Conolly (1993) focus on the decision maker's ability to evaluate the situation and make cause-coherence models as being important success criteria.

To us, operation demands are well known, and often a theme in the discussion amongst the firemen after an emergency response action. To come to an understanding of the actual situation, and based on this, to arrive at directives for changes and improvements is crucial. The decision maker is context bound, embedded in ever-changing environments. Decisions in action are decision taken under a degree of uncertainty. In April this year we had a house fire at 8 o'clock in the morning. I arrived at the scene 15 minutes after the first fire engine had been called out and it was in action. A part of the house was burning. The heat was close to setting fire to the neighbouring house and an elderly man was missing. Or was he missing? Where could he be? Could he possibly survive if he was still inside? Where should we search for him? How many smoke divers could I use? The neighbour's house was in immanent danger. The uncertainty was great. One of my task as commander was systematically to reduce the uncertainty, while carrying out the most appropriate actions. A huge effort was made to search for the man, who, unknown to us, was visiting a friend in another part of the village. Could the emergency management and the decisions and actions that were carried out have been better? What is better, really?

Situations like this are difficult. Afterwards it is easy for bystanders and the media to criticise if something of value is lost.

A strategy to establish proactive decision making is proposed:

(1) *Establish a goal and sub goals*. Ask the question; what are the threats? Without a goal (or normally many minor goals), the commander on-scene doesn't know what to do or the right thing to do.
(2) *To figure out the available time before the decision must be carried out*. When time is running the losses can increase and the question is: What can be acceptable injury, damage and loss of life, environment and economy? When do we accept the provided information as sufficient for making decisions? Brehmer (1991) talk about overload of information. That is not the real problem. The main problem is to sort out the information you need right now and the information you may need later on. A strategy to sort out the urgent and non-urgent problem and related need for information, may give the decision maker valuable time during the hectic periods. Delegation to subordinates is an effective way of dealing with low quality, non-urgent problems when time stress is high.
(3) *Determine what response performance (including emergency management) that is needed,* when to reach the goal and determine the alternative actions. How can we minimise damage or loss?

Some ideas on future research design to real-time emergency management

Most studies of decision making in action have been retrospective narratives conducted after the outcomes were known. An example of such 'historical' analysis is Rosenthal and Pijnenburg's (1991) reconstructive logic through case studies. While historical analysis is necessary for examining many questions, it is generally better, if possible, to initiate studies of decision making in action as the processes unfold in the natural field setting, before the outcome of the process becomes known. The research must aim to produce new valid knowledge, not alone to validate well-known hypotheses.

To me, when research is about understanding how to manage an emergency or to make decisions on-scene, it seems necessary for the researchers to place themselves in the manager's temporal, contextual frame. The major focus of a study would entail conducting real-time observations of the events and activities in the emergency while it unfolds-without knowing a priori the outcomes of the events and activities. To understand the causes of the changes and how they interact there is a need to supplement regularly scheduled data collection, through surveys and interviews, with intermittent real–time data.

Systematic longitudinal observation is necessary to substantiate and elaborate suitable process models of emergency management and decision making. Action research may be a valuable approach for achieving valid knowledge, and is a term for "describing a spectrum of case that focuses on research and learning through intervening and observing the process of change" (Cunningham, 1997). According to Grønhaug and Olson (1999) "action research is often difficult to conduct through experiments". Randomisation seems usually to become impossible, manipulation of treatment is often difficult, and true control groups are seldom available. An accident occurs unexpectedly and at a discrete time and it thus ensures a natural randomisation. Another research challenge is that the accidental situation develops with time, dependant on the system ability to mitigate the consequences; hence the state of the system in question could be viewed as a stochastic process (Njaa 1998). Some challenges to be aware of with action research are; the ability to control treatments, to focus on co-variation between cause and effect, to focus on time order of cause and effect, access to control groups and of course randomisation (Grønhaug and Olson, 1999).

Action research design must aim to produce valid knowledge:

- about assessment of needs throughout the different phases of an operation; i.e. prevention, mitigation, response and reconstruction

- to find coherence between interactions, actions, reflections (consequences) and changing direction during the emergency management
- to describe explanatory factors constructing our perception of emergency management and decision making on-scene
- to capture longitudinal real–life problems during the emergency management on-scene (what, why and when)

An interesting research strategy is participatory action research. It means that the researcher must be a part of the rescue team and be on call with them. If not, it is impossible to observe the whole emergency operation, and observations- data of the inherent important decisions, particularly in the initial phase, are lost. During the emergency the researcher makes adequate observation, either purely as an observer, or as a working member of the rescue service. The latter is controversial, but can be efficient if the researcher has the necessary rescue competence, integrity and position in the team.

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