UNIVERSITY OF OSLO
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Designing a resource management system for paramedics in larger emergency operations

-A master thesis in interaction design

Master thesis

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Abstract

In this thesis it has been discovered that the verbally based communication amongst paramedics is unsatisfactory. The 'one-to-all' radio communication system which is utilized today does not have the capacity needed to handle major incidents. It is furthermore fragile when it comes to both environmental noise and signal disturbances, due to the presence of for example helicopters and buildings. Thus a need for an improved communication system was identified. It was found that management of personnel and patients uses a major part of the capacity of the radio. In this thesis a suggested system will be presented as a mean to enhance the quality of communication. By designing a system which visualizes information of personnel and patients – with status, position and ID – in a real-time map on a screen, much of the information which today is provided verbally will with this system be available visually. The evaluation of the system is conducted with an Operational Commander which is defined as an end-user. The findings suggest that geospatial visualization of personnel and patients with status, position and ID, will reduce the amount of verbal communication and will furthermore improve information accuracy and enhance efficiency in management of major incidents.

Keywords: Emergency response management, triage, map-based user interfaces, visualization

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Preface

"*In the 1980's, designers and computer scientists working in the new field of human-computer interaction began questioning the practice of letting engineers design the interface for computer systems*." [1:31]. Many types of designs are results of engineering rather than a result of designing [1]. Users would therefore have to adapt to a system rather than the system adapting to its users.

In later decades there has been somewhat of an awakening around the need for better designs. In the computer world we have seen that operating systems have evolved to become more and more intuitive, perhaps especially evident in the interface design on cell phones. When Apple designed the first iPhone they revolutionized the way in which we perceive what a cell phone is, and what it could be used for. The iPhone, as many other newer designs, is a result of careful designs – both graphical and interactional.

The need for intuitive and user adapted systems is present wherever there are users. Within emergency work it is perhaps of even greater significance that a system is tailored for its users. The reason for this is obvious: Emergency work revolves around saving lives, and every second counts. Creating a system that allows its users to perform their work more efficient, even though it may only be a minor improvement, might for some patients mean the difference between life and death.

Technology is evolving by the minute, going through smaller and greater changes. Some of these changes are close to insignificant and others completely revolutionize the way we live. Keeping up with the changes in technology is one of the new and great challenges facing organizations in society today. New technologies not only changes how we use different objects – it also changes how we think and act in everyday life.

1 Introduction

On a daily basis there are few incidents where the number of patients exceeds the capacity of the ambulances available (See Appendix 3). However, incidents of this size do happen, like the Åsta-accident 4th of January 2000 [2], and the massacre at Utøya 22th of July 2011 [3]. In incidents like these there are a large number of patients as well as a large number of emergency personnel present. In the Åsta-accident for example there were 86 persons in the two trains and approximately 600 emergency personnel involved [2]. On Utøya there were 134 wounded and deceased individuals in total [3]. These incidents are only two examples out of many, and these will be further discussed in Chapter 2.2.2.

Examples of other major incidents are many, but these will not be further discussed in this thesis. The bombing in Madrid 11th of March 2004, the terrorist attacks in the USA 11th of September 2001, and the bombing in London 7th of July 2005 all involved large numbers of both personnel and patients. In addition to accidents and terror attacks we also have large catastrophes caused by nature. We all remember the tsunami in south-east Asia 26th of December 2004. Here more than 230 000 people lost their life in more than 14 countries. The hurricane Katrina in central-, and North America in 2005, and the tsunami in Japan in 2011 are other examples of catastrophes caused by nature. Incidents such as the ones mentioned above reveal that although they do not happen often they indeed do happen, and we need to prepare as best as possible for handling them.

Managing major incidents like these is a demanding and difficult task. Large amounts of data have to be considered when organizing the personnel, and every order as well as every status report has to be communicated between emergency personnel and the organizers organizers of the emergency operation. The situation is chaotic and continuously changing. Organizers ability to make the best decisions depend upon the amount and the quality of information available, just as much as personal experience from other emergency operations.

In managing major incidents in Norway today, organizers like the paramedical Operational Commanders (OCs) utilize paper-based maps and pens to acquire an overview of the incident area (See Appendix 3). Most of the communication is done verbally through the use of emergency radios and cell phones [3]. Even though the new emergency radios support text-messages called SDS-messages these are rarely used [3]. The emergency radio is a '*one-to-all*' communicative tool and users have to wait until the net is available. Experience from previous major incidents have proven this to be an unsatisfactory mean of communication due to the radio's limited capacity [3] (This was also commented by the interviewees in Stavanger). The way in which communication is organized is different from one agency to another. This lack of consistency has proven to be a problem, as experienced during the incidents on 22th of July 2011 [3]. After these incidents it has been advised by the Norwegian Department of Health that "*Communicational systems utilized during catastrophic events have to be improved and coordinated better*" [3:14] (Translated freely from Norwegian). They furthermore encourage more collaborative training exercises between agencies to better handle major incidents when they occur.

Designing tools to enhance communication and information sharing during emergency incidents has to be tailored to the needs of its users. Using Donald A. Normans terminology a system would not only have to provide satisfactory *effectiveness,* i.e. provide the data needed by its users, it has to present this information to the users emphasizing *efficiency* and *learnability* [4]. Emergency personnel will not use a system which will slow down the emergency operation even though it may provide information valuable to decisions being made, simply because every second counts and could mean the difference between surviving or not for patients in these incidents [5].

1.1 Objectives

This master thesis had four main objectives:

1. *Identifying the challenges and user needs regarding resource management support in larger emergency situations*. This implied a need for research on how personnel are managed in larger emergency situations today. Based on this research, challenges were identified and user needs defined. This objective is covered in Chapter 2 - 5.

2. *Designing a system that will tackle the challenges identified, and that emphasize meeting the needs defined.* This is captured in Chapter 6 and 7, and is further presented and discussed in Chapter 11 and 12. Further research and development regarding the system has been suggested in Chapter 13.

3. *Creating a prototype of a user interface based on the results gathered from objective 1. This interface is a central part of the system suggested in objective 2*. The interface was tested and further developed in three iterations. This process is described in Chapter 7 - 10, and is further discussed in Chapter 11. In Chapter 13 future work is pointed out regarding this prototype interface.

4. *Analyzing the prototype with the end-users and derive design implications for future work*. Here it is important to involve the end-users since they are the ones that are going to interact with the system. This was done with the third prototype and is described in Chapter 9. In addition, a brainstorming

session with usability experts [6] was held considering the first prototype. This can be found in Chapter 7. The second prototype was tested through opportunistic evaluations, and is described in Chapter 8.

1.2 Research question

The research question in this master thesis was based on an early '*contextual inquiry';* - where the goal was to construct a rich understanding of the actual work situation with focus on roles, responsibilities, problems and tools to name a few [7]. The inquiry consisted of interviews, observation and document analysis and the findings are presented in Chapter 5. The following research question was defined:

'How can mobile technology help improve management of paramedical personnel in larger emergency situations.'

Conclusions regarding the research question are presented in Chapter 12.

1.3 Chapter guide

To provide an overview of this thesis I have divided it into four parts:

1. The first part, including Chapter 2 - 4, presents the background and theory that this thesis work is built upon. Here the context for the research is presented as well as the methods and theory used.

2. The second part, including Chapter 5 and 6, presents the results from the early contextual inquiry and tries to derive some design implications from this.

3. The third part, including Chapter 7 - 10, describes the designs suggested and the iterative process in which the design was developed. This process is described chronologically and design implications are presented where they were discovered.

4. The fourth part, including Chapter 11 - 13, discusses the findings uncovered in this thesis work. A short conclusion is also presented. Future work is presented in the last chapter listing new questions that have arisen during the course of this master thesis and that I was unable to research due to the limited time available.

2 Background

In this chapter we will describe the background for this master thesis. The context in which the thesis has been written is introduced and the area of focus is presented. Also some design implicating factors related to emergency work are presented, as well as a short introduction of available and/or plausible technologies that can aid paramedical work.

2.1 Research context

This master thesis was written in cooperation with SINTEF, and was a part of the EMERGENCY-project (Mobile Decision support in emergency situations). The project was given a lifetime of 4 years, set from November 2008 to October 2012. This master thesis was a part of the project from August 2010 to May 2012.

“The purpose of the research project EMERGENCY (Mobile decision support in emergency situations) is to improve decision support in emergency situations based on systematic experience-gathering and state of the art support for real-time information access. EMERGENCY is partly funded by the Research Council of Norway, and runs from November 2008 to October 2012.” [8].

As a part of this project a group of researchers explored new ways of improving resource management in emergency situations. One of the focus areas in the EMERGENCY project was languages and methods for design, and development of user interfaces supporting mobile emergency responders. This research was done by Erik G. Nilsson, a Ph.D. candidate at SINTEF ICT, who also was the main supervisor for this thesis. A number of master theses were written in contribution to the research conducted in the EMERGENCY project. Each focused on different tasks within different emergency response agencies.

Suhas G. Joshi, in his master thesis, designed an interactive system for resource management within the police. His system provides functionality for allocation, and re-allocation of resources. It was created on and for the Android platform. Another master thesis, written by Aslak Eide, investigated new ways of managing risks through visualization. His research revolved around the specific risks related to fires, and was conducted within the domain of the fire agency.

The master thesis you are currently reading was a third thesis which revolved around emergency response. The focus in this thesis was to compliment the two other master thesises which was delivered half way through the course of this one. With research already conducted within the police and fire agencies, it was natural to investigate how new technologies could improve resource management within the third agency, namely the paramedical.

2.2 Emergency response

Responding to emergencies is a task that demands fast and effective action, and is often situated in life-threatening situations [9]. "*Acute emergency situations are characterized by high levels of uncertainty combined with a need for fast and reliable action*" [10:17]. Major incidents – like train accidents or terror bombings – are characterized by "*too few resources for the amount of work to be carried out*" [9:301]. These situations are often chaotic and stressful with a large number of resources and patients. This makes it extremely difficult for anyone to obtain and maintain an overview of the incident operation [9]. "*There is no way to exactly predict who is going to be doing what, when, why, and/or how at the command and control level in a crisis environment"* [5:29]. Defining a stereotype response procedure can therefore not be done due to the nature of emergency incidents making it very difficult to prepare for them; "*Almost everything in a crisis situation is an exception to the norm*" [5:29].

2.2.1 Paramedics

In 2010 there were more than 3404 full year employments in the ambulance service [11]. The same year it was recorded 591 153 different paramedical operations involving ambulances [12]. A large number of these operations are considered by the paramedics as being simple transport missions. These transport missions involve picking a patient up at his or her home, and delivering him or her at the closest medical institution. During these operations the paramedics perform a quick assessment of the patient's condition, the patient's environment, and if they find it necessary – contact the nearest hospital, describe the case, reserve a spot for the patient and transport him/her to that hospital (See Appendix 3).

Paramedics also often encounter accidents with severely injured patients and casualties, e.g. car crashes, overdoses and individual injuries. In these operations time is limited and the paramedics have to be as efficient as possible. In most of these incidents the number of injured patients is less than the transport capacity of the ambulances available, and the focus is to get the patient(s) straight into the ambulance and quickly to the nearest medical institution. There is little consideration of who to prioritize since all patients can be transported immediately.

In addition to these "routine" operations, the paramedics can also encounter large operations – like major building fires, train crashes, avalanches and other incidents with multiple wounded and/or deceased patients. In operations of this magnitude the number of patients exceeds the available transport resources, and some patients have to wait on the scene until transport is available. These incidents have a large potential for efficiency improvement, and it is these incidents that were the main focus of this master thesis. They are referred to as '*major incidents*'.

2.2.2 Learning from previous major incidents

There are a few examples of major incidents occurring in Norway. Looking into what was done and what was learned from these incidents might provide information on how future incidents of this scale might be organized better. In this thesis we will look into two fairly recent incidents: The train accident in Åsta 4th of January 2000 [2], and the bombing and massacre in Oslo and on Utøya 22th of July 2011 [3]. In major incidents there is normally conducted what is known as a *triage*.

Triage

The first emergency personnel that arrive at an incident area normally starts by acquiring an overview of the situation. In major incidents this means quickly going to every patient in the area and consider their condition. Each patient is then given a priority level and each patients position is noted [3]. The patient is also given a physical tag which communicates the priority level and patient ID (A picture of this tag can be seen in Figure 14). The triage is done as quickly as possible and the triager does not perform any treatment while triaging. It is this information which provides the overview of the area for the Operational Commander, and it is based on this information that the personnel are managed.

A good triage is important when it comes to saving as many as possible. Critically injured patients are prioritized over severely injured, while patients that are dead or 'unsavable' are managed only after all other patients have been dealt with. The triager has to be experienced enough to see who is savable and who has the most imminent need of treatment. If the resources are used wrongly it can result in the death of patient that otherwise could have been saved.

Local control post

"*Operations during emergency response are usually lead from a local control post, which is close to the scene of the incident, often outdoors or in a car, caravan, tent, etc. As soon as the leader at the local control post obtains a situational overview, an operational area is defined.*" […] "*Field workers performs given tasks inside in the operational area*" [10:17-18] (See also Figure 1). The local leader for paramedics is called 'Operational Commander'[1]. It was for this user group the interface suggested in this master project was designed.

Communication

Paramedics rely mainly on voice communication [10]. If the paramedic needs to communicate with someone who is not within his/her closest vicinity they use either the emergency radio or mobile cell phones. During the interviews conducted in this master

[1] Operational Commander is known as 'Operativ Leder Helse' in norwegian.

project they also reported some use of body language, but this is not taught and can therefore easily lead to misunderstandings.

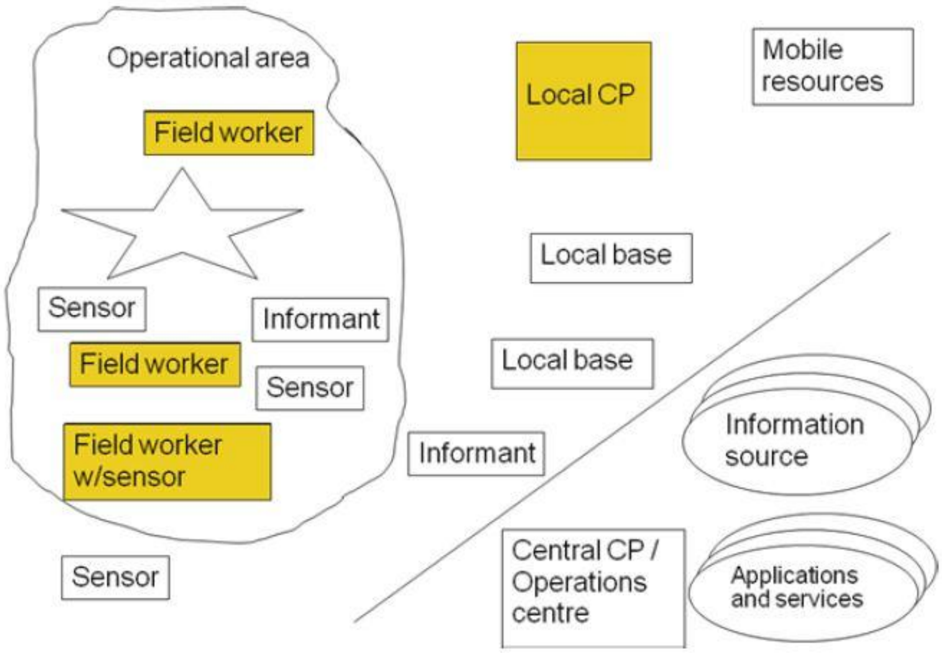


Figure 1 – The organization of paramedics during a larger incident [13:1].

The Åsta-accident

4th of January 2000 two trains collided in Åsta in Hedmark, Norway. The trains front collided, each with a speed of approximately 90-, and 80 km/h [2]. Totally 86 persons were inside of the trains when they collided. 19 persons lost their lives. A total of approximately 600 personnel were involved in the operation [2].

There are two experiences from which we can learn. First the organizers of this accident got an inaccurate overview of the situation. It was not known until four days after the accident how many persons were inside of the two trains. The organizers got information from NSB, the train company, that there were a total of 96 passengers based on ticket sale, 10 more than it really was [2]. As pointed out in the report, not every passenger buys a ticket, and not every ticket is used. This means that the organizers could not trust this information and had to count patients as they were reported in. A triage was done and patients were reported in verbally through the use of radio. This took time as well as radio capacity. Having a system which could visualize the patients as they were found and automatically count them as they appeared in the system would help the organizers get a better and more accurate overview more quickly.

The second experience is that it was difficult to investigate the organizing of the emergency personnel due to lack of logging. The personnel did not prioritize logging what they did because they perceived that it would be better to concentrate on the emergency situation and the patients on the scene. "*People in emergencies […] have no tolerance or time for things unrelated to dealing with the crisis*" [5:29]. Logging is important so that we are able to learn from emergencies in the past so that we can improve the management of emergencies in the future [5]. As further commented in Chapter 13, a computer based system could easily create an incident log automatically without requiring the attention of the emergency personnel.

22th of July 2011

There are few Norwegians who do not remember what happened 22th of July 2011. Both the bomb in the center of Oslo and the massacre on Utøya were considered major incidents, and both areas were triaged [3]. Relating to this thesis there were made a few experiences worth noting.

Different triage systems

The triaging of both incident areas was considered very good and as critical for the further course of the operations. It was noted however that the systems and routines for triaging were inconsistent between different municipalities. Both triaging equipment and terminology differed causing uncertainty in the management of patients. The quality of the triaging was in the report considered to be a result of the high experience amongst the triaging personnel, and they note that if the personnel had been less experienced the inconsistency of triaging systems might have greatly reduced the quality of the triages [3]. Today there is no national system for triaging in emergency incidents, which is regarded as less than optimal. It was advised in [3] that "Central health authorities has to ensure that a consistent national system for triaging of patients is introduced [3:16]".

Communicative problems

The emergency personnel reported major problems with the communicative equipment and routines [3]. The signal coverage was not satisfactory and at times some field workers experienced having no signal at all. Furthermore was the problem of one-to-all communication highlighted. The amount of information needed to be shared greatly exceeded the capacity of the emergency radio during the operation [3]. Even though the emergency agencies recently got a new emergency radio system, the medical communication during the operation at Utøya was conducted using the old emergency radio system, supplemented with private cell phones [3]. Furthermore the personnel did not utilize all the possibilities afforded by the emergency radio, like for example SDS-messages (I.e. *Text messages*) [3]. This uncovers three things; First that the radio system is not fully intuitive and secondly that the training in the use of the radio system is unsatisfactory. Thirdly we see that the emergency personnel were highly dependent on voice communication through radio [3]. This observation is also supported by experiences from other incidents as well [10].

The personnel furthermore experienced that the radio system in shorter periods had technical problems and that they could not rely on it at all times. They also found it to be a problem that one would have to wait until nobody else used the radio before they could speak [3]. This becomes a problem mainly in major incidents. One implication of high radio traffic other than having to wait before one can speak, is that it becomes difficult paying attention to everything being said. Sorting out the information that is of importance to oneself can prove to be demanding [3]. This caused many of the personnel to use their cell phones instead to communicate with each other, and with hospitals. There has been reported from both incident areas (I.e. Oslo and Utøya) that the mobile network was highly unstable and at times completely unavailable. "*This created risk and vulnerability concerning availability of important resources, communication of time-critical information, overview, management and coordination of incident and effort*" [3:53]. The report concludes that the system and routines for communication to be used during major incidents like these has to be improved and coordinated better [3].

Daily use

The report emphasizes the need for routines and experience when handling major incidents [3]. There is no time to learn how to use new equipment and experience from the use of the old emergency radio show that the emergency personnel will use what they are familiar with rather than what might be the best technology. The report emphasizes, based on these thoughts, that technology which is to be used during major emergency operations should also be used on a daily basis [3].

Also when interviewing the paramedics during the research for this thesis it became clear that if the paramedics are to use any new technology or system during a larger incident with multiple victims, it is important that they are familiar with it and know how to use it. Experience from emergency response in general, not only from 22th of July 2011, reveals that emergency systems that are not used on a regular basis before an emergency situation will not use it during one either [3, 5]. This means that the system should be designed in a way that also makes it useful during more "routine" transport operations while still being scalable to larger and more complicated operations. If the system could not be used on a daily basis however it would have to compensate by being extremely *learnable*, i.e. understanding how to use it has to be easy [4].

An interesting theory emphasizing the importance of experience with the equipment is a theory known as '*Fiedler's cognitive resource theory*' [14]. It states that during situations with high levels of stress intelligence is negatively and experience is positively related to performance, whereas the opposite is true during low stress conditions. The system described in this thesis is to be used in major incidents which have high stress conditions. Users should therefore know how to use the system before handling such conditions.

2.3 Humans as users

When designing a system for a user group it is important to not only focus on the factors that separates the defined users from other individuals, but to also consider the factors that are specific to being human in the use context. Many environmental factors influence humans' abilities to process information and to act. In this master thesis two psychological phenomena are presented: '*Stress*' and '*information overload*'. These phenomena are highly relevant to emergency response situations and the management of these.

Stress

It is important to consider stress when creating new systems which could be used in high-stress situations. Too much stress can cause the users to make more errors, due to lower levels of concentration and judgement, and might therefore result in more accidents [14]. Making errors in emergency situations could result in unnecessary casualties, and any system designed for this use context should therefore focus on reducing the opportunity and likeliness of error-making. Stress can also make the users want to avoid the system. This means that the users will when possible use other systems that are experienced as less stressful. Ultimately stressful systems can, when they are unavoidable for employees, increase the amount of absenteeism from work [14]. Additionally too much stress over time might actually be a health risk for any individual, in some cases causing what is known as burnout [14].

The situations that paramedics operate in are often stressful [10]. Local leaders have to consider large amounts of information in time critical decision making [10]. J. McGrath's definition of stress is much quoted: "*A potential for stress exists when an environmental situation is perceived as presenting a demand which threatens to exceed the person's capabilities and resources for meeting it, under conditions where s/he expects a substantial differential in the rewards and costs for meeting the demand versus not meeting it.*" [14:358]. This is especially true for major incidents where both the feeling of lack of control, over- or under-stimulation of the senses and isolation might occur. These are all identifiable reasons for causing stress in an individual [14]. In emergency situations the lack of information is known to aggravate fear and stress levels [15].

These feelings are however to some extent subjectively experienced [14]. The feeling of lack of control for example only occurs to someone who experiences that the amount of data received is not enough to assess what actions to take. The feeling of being isolated only causes stress if one does not think that you alone with your equipment can handle any foreseen challenge. Some people are in a higher need for information, are more easily stressed by stimulation of the senses and are more dependent on others [14, 16]. For paramedics it is difficult to do something about the amount of stimulation the senses are exposed to. But enhancing the amount of information available and improving the quality of communication can certainly reduce the amount of stress experienced by all emergency personnel in major incidents, thereby also potentially reducing the amount of errors made during these incidents – thus, to the ultimate extent, saving lives.

Information overload

In major incidents such as the ones mentioned earlier the decision makers, e.g. the Operating Commander, has to consider large amounts of information [10]. Getting a correct overview of the situation is both attention requiring and difficult. Not all information is relevant for every decision. The OCs should therefore be able to filter away unrelated information and base their decisions solely on that which *is* relevant – thus saving precious time [7, 10]. Being presented with a large amount of data also makes it harder for the user to determine what information is important for him/her, and what is not. This can cause confusion. Processing large amounts of information is in addition to being time consuming and confusing also known to cause stress. The level of stress especially increases if the user experience the amount of information to exceed his/her ability to process this information – thus leading to a feeling of lack of control [17]. As we discussed earlier, this feeling of stress will increase even more if the user perceives that the consequences of actions, or absence of actions, to be severe [14].

When the amount of information the user has to process exceeds what the user perceives as their processing capacity what is known as '*information overload*' [17] can occur. This phenomena causes a sort of cognitive paralysis [17]. A user experiencing information overload will be easily distracted, process information less efficiently, experience stress and make more errors [17]. It is important when designing for OCs that they are not drawn away from their primary tasks by either unwanted functionality or by information that is not related to the decision at hand [10]. This was kept in mind when designing the information system described in this master thesis.

In this master thesis two combinable techniques has been used to reduce the chance of information overload in the prototype interface. One way was through implementing filters, enabling the removal of information that was unrelated to a decision process [7, 17]. This was because being able to filter information out of the interface would reduce the amount of information being presented. Another way was by structuring information [17]. Grouping correlating information enabled the user to distinct different types of data from others, thereby filtering the information presented cognitively.

2.4 Technology

As new technology emerges new opportunities arises. Keeping up with the changes in technology is one of the new and great challenges one faces in society today. Technologies not only changes how we use different objects – it also changes how we think and act in everyday life.

To be able to understand what possibilities new technology offers we also have to understand what kind of technology the user group utilize today. Although new technology generally is more advanced and complex it is not always better than old technology. Writing this master thesis on an iPhone would for example not be a better alternative than using a stationary computer with a QWERTY-keyboard and mouse. One has to look at what the users need and what they are able and willing to use.

Not all technology currently being used by paramedics is what we could call 'top modern'. Paper maps, the use of paper and pens, and paper slips are used to organize the resources in an incident area. The use of emergency radio compliments the direct verbal communication amongst the paramedics. In some cases cell phones are used to communicate directly with personnel at other locations and with hospital organizers.

In the ambulances however digital technology has been implemented providing digital maps and a text-based reporting system. In some parts of Norway for example they are currently using a system known as LOCUS. This system enables for simple non-verbal communication through the use of text-based messages for mission description and status reporting purposes. The maps offered enables the paramedics to see where they should drive, like a GPS-navigation system. This system however is not mobile and cannot be removed from the vehicle. This means that it is not usable outside of ambulances and that it is therefore not suitable for other purposes than transport and reporting while the paramedics are physically inside the vehicle.

There are many technologies that could be used to improve upon resource management amongst paramedics. Maps can be made interactive, patients can be automatically displayed in the map, communication could be made visual with the use of text or symbols etc. In this master thesis a Galaxy GT-P1000 tablet was chosen as the device to design for and to test with. This device was chosen on the basis of two considerations. One is that I won one in the early part of the thesis work, thus making it easily available. The second is based on its size. The tablet is smaller than for example an iPad being only 19 x 12 cm versus iPad's 24 x 19 cm. This makes it easy to operate with one hand and therefore more mobile than larger devices. It is however still big enough to display a map with icons in it, and allows for a better overview than smaller devices.

2.4.1 Why Android?

Android is a free, open source development platform and operative system developed especially for mobile devices [18]. This is attractive for developers all over the world as they may create their own software without paying for the development tools. It is liked by handset and plug-in makers because they can use and customize the platform without paying large fees. And it is favored for its versatility – it is not locked to one single firm that may go bankrupt, and it may be used on a variety of devices.

The Android operating system provides a level of system stability *"… not seen before in smart phones."* [18:11] This is because each program is isolated from each other by multiple layers of security. It is built on a Linux kernel and the Android development language is based on Java. However, it somewhat differs from straight forward java programming as it is optimized to run more efficient considering the limited memory and battery-time offered by mobile devices[18]. This is done through the use of the Dalvik Virtual Machine, developed by Dan Bornstein at Google. The Dalvik VM compiles the code *"into machine-independent instructions called byte codes, which are then executed by the Dalvik VM on the mobile device." [18:33]* Instead of running .class files and .jar files as the Java engine does, the Dalvik VM runs .dex files, which are more compact and more efficient. The Android development language also differs from Java, although there are overlaps, when it comes to the core libraries.

These differences, however, are not major and if you know the Java development language, or a similar object-oriented language, learning the Android development language should be an easy task. Furthermore, you don't need any prior experience developing software for mobile devices when learning to develop for Android.

2.4.2 GoogleMaps

When implementing a map in Android GoogleMaps is a great alternative. It is highly developed both regarding map details as well as regarding functionality. It is furthermore tailored for use in Android applications. One could possibly use other map services as well, such as OpenStreetMap and national map systems, but as GoogleMaps meets the needs in this master thesis it was this that was chosen. There are many forums and guides on how to implement GoogleMaps into an application. There were however some problems regarding the 'Maps API Key'. I will not go into detail on the problems that arose, but I strongly recommend that anyone wishing to use GoogleMaps in their application should *thoroughly* read *multiple* guides on the matter. This will save you some time.

For those who are unfamiliar with GoogleMaps I will now shortly present the functionality provided by it. First of all, GoogleMaps is an interactive digital map which provides map data of a large part of the planet. It provides functionality for panning and zooming on both touch screens and with mouse on computers. It also allows users to choose whether or not they want to use a traditional map view or rather a satellite view of the area. Furthermore it has a well developed framework for development making it easy to for example place markers in the map.

In this master thesis I have chosen to use only the traditional map view, and chosen to not make satellite view available. This is based on a hypothesis perceiving traditional maps as less cluttered and as a better mean to seeing an area than a satellite photo. In countries like Norway it could be very disturbing looking at a summer photo of an area when it is meters of snow there during an emergency incident. Choosing traditional maps instead gives a simplified and accurate overview of the area. This hypothesis is not tested during this thesis, and is regarded as a basic assumption. Prior to a full scale implementation testing of this hypothesis could preferably be conducted.

2.4.3 Technological challenges

If an Android-driven handheld device is to be successfully implemented as standard paramedic equipment it is essential that it is reliable. This implies that the technology will still work even though it will be used under tough condition.

For example, one has to consider the weather. Any handheld device used by paramedics in the field should be waterproof so that it can be operated when it's raining. It is also important to consider the temperature. In some places, like Finnmarksvidda in northern Norway, the temperature can drop as low as –51,4 °C (Karasjok 1th of January 1886). Temperatures below -40°C are not uncommon in northern parts of Norway where paramedics operate. It is therefore important to consider how well the technology will work under such conditions- both in not breaking down, but also when it comes to operating the device with i.e. gloves. During one of the interviews conducted in this master thesis the users reported that even though they have gloves available during the winter, they rarely use them because they tend to get in the way of their work (See Appendix 3). They do, however, use rubber gloves, often two or three layers of gloves at the same time, and thus the technology should be designed with this in mind.

Sometimes the operator might have a need for operating the device without hands. This might be met by different modalities. Gloves, as mentioned earlier, might be used by the operator and it is therefore important to have a modality that can be operated without taking the gloves off. This is also found in [10]. Touch screens like the ones on iPhone are not usable with gloves. This can be solved either by using a non-touch modality, using a stylus to operate the device, or by equipping paramedics with gloves suitable for touch screens.

Another challenge when choosing technology for paramedics is durability and robustness. Operating in the field means sometimes running, walking on icy or oily ground and sometimes even crawling. If a device-operator falls down or drops the device on the ground it is important that it doesn't break. As paramedics might have blood or dirt on their hands while operating the device it is important that it is easily cleanable, and easy to disinfect.

These are all technological challenges that was not researched any further in this master project. It is however important to emphasize these challenges if the system suggested in this master thesis is to be implemented for paramedics.

2.4.4 Medical sensors

To get a better understanding of the sensor technology currently available for monitoring of vital signs, an interview with an expert on sensors was arranged. The interviewee is considered to be an expert in bioinstrumenting at SINTEF, Oslo. She has, amongst other projects, worked on a system to improve decision support for subjects exposed to heat stress. This system uses sensory data to determine the subjects' current health status, the subjects in that project being fire fighters. The data recorded enables quicker and more detailed risk assessments of the situation. The data collected by the sensors in that project were heart rate, skin temperature and movement through the use of accelerometers.

Experiences drawn from that project is of relevance to this master thesis. Both heart rate and skin temperatures are important information when it comes to the assessment of a patient's status. Accelerometers concerned with the subject's movements however will not be as important when it comes to patient status assessments. The reason for using accelerometers in that project was to record if a fire fighter suddenly stopped moving, thus revealing that s/he might have fallen or fainted. Patients generally do not move around in the same way fire fighters do and this information is considered to have little validity for patient management. We can argue though that personnel could profit from having accelerometers as a wearable. However, due to the low risk of fainting in emergency environments where other personnel than fire fighters operate, it is regarded as obsolete and of little interest.

Breathing sensor

There is also possible with breath monitoring. This can be accomplished through registering of the patient's breast-volume. Breath monitoring can also be accomplished through a breathing mask, but this system would be too time-consuming, as the system has to be completely sealed in order to work, and the equipment would be too heavy. This means that to monitor the patients breathing one need to have sensors attached in the breast-area on the patient. The sensor expert personally finds breathing data difficult to interpret as most people breathe in different ways. She does however acknowledge that the sensors easily could tell if a patient is breathing or not, and that this data would be useful.

Pulse oxymetry probe

Another way to monitor both breath and intoxication is through pulse oxymetry probes. This is a sensor that is easily mounted to one finger of the patients, and is completely noninvasive. It uses light with different wave lengths to scan the blood of the patient revealing the oxygen saturation in the bloodstream [19]. The drawback of pulse oxymetry is that it has to be placed on fingers or toes to enable the scan. If a patient is suffering from blood loss or hypothermia the body shuts down the bloodstream to the limbs. When this happens the sensor will give data indicating that the patient is dead even though the patient is alive and savable. If these sensors could be placed at more central areas of the body the data collected would prove very useful.

Skin temperature sensor

Core temperature is another indicator to a patient's status. But in order to measure this one need to get a sensor into the core of the patient, something not practically or hygienically possible outside a sterile hospital environment. One could however monitor the skin temperature at one or more locations of the body. More sensors reveals a more thorough picture of the patient's current body temperature, but is also more time-consuming for the paramedics applying these sensors onto the patients body, even though applying a skin temperature sensor is easy; it just has to touch the skin somewhere. More sensors also mean more weight and consume more space, even though these sensors are light and small. If one should limit the temperature monitoring to one sensor it is important that the sensor is put at a place where skin temperature doesn't vary much from the core temperature. This means either torso or head.

Heart rate

Heart rate is an important parameter when assessing a patient's status. Therefore a system for patient monitoring in the field should have a sensor monitoring the patient's heart rate. The sensory expert has seen many different attempts at monitoring this, but has never seen any location better suited for heart rate sensoring than the torso. Sensors put in other parts of the body gives too inconsistent and vague data to serve as monitoring data. She does say however that pulse oximetry quickly reveals if the blood lacks oxygen from not breathing, but as described earlier the limbs are not great areas to put sensors.

Other sensors

Even though there are a few useful sensors available, there are many that are not suited for the system developed in this master thesis. Accelerometers are already mentioned as not suited for this thesis. When asked about brainwaves the sensory expert points out that they are not easily monitored, nor easily interpreted and requires many sensors on precise areas of the scull. This is not something that paramedics can use outside of hospital.

There is also a technology known as EMG sensors. These sensors monitor muscular activity, and are often used on patients recovering from muscular damage. They need to be positioned directly on a muscle in order to function however, and might therefore be time-consuming regarding placement application. They are mentioned because they might be designed to record the heart, since this is a muscle. The accuracy needed for placement on patients is however regarded here as a drawback to such a degree that they are abandoned in this thesis as possible sensor technology.

Placing the sensors on the patients

Discussing with the expert on sensors at SINTEF has made it clear that the easiest and best way of monitoring a patient in the field is through the placing a multisensory device in the breast-area of the patient. There are two ways of doing this: 1) Using a belt with all the sensors attached, and placing this around the patient's torso. This is what the sensory expert did when collecting heart rate, skin temperature and movement data. Monitoring breath could be done with sensors registering the changes in size of the belt, which has to be elastic. One could place two electrodes with some variant of glue or tape to the patient's chest. This would enable the same sensory data as with the belt; Heart rate, breathing, and skin temperature monitoring.

2.4.5 Location

Once the sensors are attached to the patients the organizers at the scene can start sending personnel to the most critically wounded patients. If the organizers can see where the patients and the personnel are in a map, it would be possible to save time by appointing patients to the personnel closest to them. When the personnel have been appointed a patient they should be able to see where the patient is in relation to themselves. This could be visualized either in a map or as an arrow pointing in the direction of the patient. Information of how far from the appointed patient the emergency worker is should also be provided.

It is therefore a need for some kind of localizing technology [10]. This could be done by using GPS as has been suggested by others [10, 19]. Whether GPS is suitable or not in emergency situations is the question of accuracy. Garmin, a GPS manufacturer, operates with an accuracy of 15m in average [20]. Since GPS work by receiving radio signals from four or more satellites and calculating the relative distances to each one, it is fragile when it comes to both landscape and other radio-signal noise. Mountains can for example generate up to 30 meter accuracy error, while noise can add another 10 meters [21]. A locating technology used to organize emergency situations should offer a better accuracy if it is to gain the trust of the users.

In addition to the challenge of accuracy there is the challenge of indoor environment. GPS technology need a clear view of the sky to operate, and would not work in for example basements or inside large buildings. Since a lot of paramedics missions are inside buildings and tunnels there is a need for another technology than GPS.

One suggested technology could be the answer to this challenge and is called CodeBlue [19]. Small low-powered wireless devices that can communicate amongst each other could work as an ad-hoc location system [10, 19]. "*By wireless ad hoc network, we mean a network that is intrinsically available through the nodes in the network, being sensors and devices with networking capabilities, and possibly portable and stationary devices whose only task is providing network connection between other sensors and* *devices*" [10:21]. Using stationary devices, also called beacons, to detect and triangulate wearable sensors would allow personnel and patients to be located inside as well as outside [10]. It is suggested that buildings can have their smoke detectors replaced by such beacons making the system already available if an emergency should occur there [19]. Mobile and deployable beacons could be used inside buildings and tunnels where such beacons are not already installed. The CodeBlue system uses a Radio Frequency (RF)-based location system [19]. In general wireless ad hoc networks are regarded as well-suited for the setting of emergency response [10].

As further suggested in Chapter 13.1, the users should also be able to manually insert and move icons in the map – thus offering the same functionality that is offered by the paper based maps utilized in major emergency operations today. In areas with poor or no signal coverage, manual icon placement and movement might be the only possibility for area management. Furthermore, if the accuracy of the location technology is poor users should be able to calibrate the system by moving a node to its known location from where it appears in the map [10].

It is important that the localizing technology used to implement a system for emergency management is accurate everywhere, both inside building and outdoors. Some suggestions have been discussed as to how this can be met. Thorough research is needed into how accurate emergency personnel need the location technology to be, and how to achieve this accuracy. However, due to the limited timeframe and scope of this master project further research into this challenge was not conducted here.

3 Research method

The purpose of this chapter is to introduce the overall approach applied throughout this research. Reasons for *why* the research methods applied are of a qualitative nature, what the basic assumptions for research are within the interpretive paradigm, as well as reasons for choosing case study as a research strategy are discussed. The aim of this master thesis was to research how one can improve the efficiency of paramedics in the field. This research conducted was used to design a system aimed at improving efficiency during emergency response situations.

To understand where the potential for improvement of efficiency lies it is important to approach the problem area from multiple perspectives with different methods, thus ensuring what is known as '*triangulation'* [22]. There are two reasons for this. First it is important because it gives a broader understanding of the problem area. Secondly, and perhaps most important, is that every perspective also is limited by its angle. As written by Wagner et.al. [23:9] - *".. The question of what we know should be tightly connected with questions of how we know it."*. How we know something is tightly connected to both the method used to obtain the knowledge, as well as the methods used to analyze it. In addition one should always be aware that every person is colored by their own subjective mindset – even the researcher [16] (Triangulation is discussed further related to validity and reliability in Chapter 11.1).

Knowing when there is enough data gathered to make the best design decisions is another great challenge. *"There are obvious problems connected with determining when there is 'enough knowledge' – and sometimes you cannot tell that you do not know enough until you fail"* [23] p.113. The more one continues to gather data, the lower the risk of creating something that does not meet a need amongst its users. However gathering data also takes a lot of time, and at one point one has to complete the research. Most research projects have a deadline, and time is almost always a constraint when designing [1].

One way of minimizing the risk of failure is to involve the users in the design process. The users are experts in their field and can provide key insight not only to design criteria, but also into what is adequate and what is obsolete [23]. Involving the end-users is therefore key when it comes to defining both problem area and user needs. Focusing on the real users and their goals as the driving force when developing a product is often referred to as '*user-centered design*' [6]. This master thesis is inspired by this approach and strives to maintain this focus throughout the design process.

One challenge when designing for paramedics however is that they are not easily available. Their schedule is unplanned, and when they are working they are constantly on the move. Since there is no extra room in an ambulance and no possibility of following them around when they work conducting interviews or involving the paramedics in other research methods means that they have to report to their central that they are unavailable while contributing to the research. Even so we have been able to involve them in key parts of the research process through interviews and observation. For more general user-involvement students have played the role as paramedics. This is not ideal, since students does not have the mindset of paramedics [16, 23]. This is however accounted for and the methods that involve students are not considered to be addressing paramedic -specific design choices.

All personal data that is not necessary to reveal in this thesis work has been made anonymous. Written

3.1 A chronological overview of the thesis

Throughout this master project there have been a number of phases. To better understand how the work was conducted these are listed up chronologically. The process of design has been an iterative one, and can be divided into these 10 phases:

1. 'Contextual inquiry' - Here interviews, observation and domain specific document analysis were used for the purpose of acquiring contextual knowledge. The results from the interviews and observation are presented in Chapter 5.

2. Learning Android. Since I had no previous knowledge of Android, neither as an operative system nor as a development platform, I had to learn it from scratch. In this process I used a book called '*Hello Android*' written by Ed Burnette [18]. This book however only covered the most basic parts of Android, and to further advance my understanding I used internet forums.

3. Developing the First prototype (See Chapter6 and 7).

4. Conducting a '*brainstorming*'-session where the system was analytically evaluated, but where the main focus was to design intuitive icons and suggest further development of the prototype and system. (See Chapter 7.1)

5. Icon design. Using Adobe Photoshop CS2, which is provided by the University of Oslo, and with the excellent aid of Joakim Bording we created icons (Presented in Chapter 7.2.2) based on the results of the brainstorming session mentioned above. Also a questionnaire was used to test a hypothesis of the users' interpretations of colors as a communicational tool (See Chapter 6.2.1). The colors tested were the ones that are currently being

used in communication today together with one suggested in the 'brainstorming' session.

6. Based on the feedback gathered in the brainstorming session a second prototype was developed and the new icons were implemented (See Chapter 8).

7. The second prototype was tested and evaluated through '*open-ended interviews*' (See 3.5.1 - Interviews) and '*opportunistic evaluations*' (See 3.6.1 - Analytical evaluation) by peers [6] (See Chapter 8).

8. Based on the feedback gathered a third prototype was developed (See Chapter 9).

9. The third prototype was evaluated by work-domain experts in a '*cognitive jogthrough' [24]*. This method is presented in more detail in Chapter 3.6.

10. After the third iteration of the prototype a final prototype was developed and presented (See Chapter 10). Although this is the end-result of this master thesis it is not regarded as a finished product. Further testing should be conducted, and the process of evaluation and development should be iterated until both designer(s) and users are satisfied. Some of the research that it was not time to complete is presented in 'Chapter 13 - Future work'.

3.2 Designing a design process

There are many different approaches to a design process. The usefulness of each approach is determined by what the designer wishes to accomplish. In this thesis what is known as '*systems design'* has been utilized. There are many reasons for this which will be discussed shortly here.

First of all let's look at the goal of this thesis – '*Researching how mobile technology might help improve resource management for paramedics in emergency situations'*. This implies that we are not looking at a simple user-to-device research. Resource management is a complex issue, and has few clear solutions. Different types of actors, ever changing environments and coordination with other emergency agencies reveal some of the complexity one has to consider when designing for resource management of paramedics.

The complexity of the issue imposes on us as designers to not only focus on what one certain type of users perceives as desirable in a device, but rather to focus on creating a system which enables for better resource management amongst all users. This does not mean that the users' perspectives have not been central in the design process. It is always important to emphasize both the users' needs and the users' experiences when interacting with a device or system. It rather means that the system as a whole has been the main focus of the designer. Like user-centered design the core of systems design is understanding user goals. But the systems approach also looks at users in relation to a context and interaction between themselves and with different devices [1].

"Systems design isn't only about digital products" [1:39]. The greatest strength of this approach is the usefulness of seeing the big picture. It is important to emphasize with a systems approach that every detail is a part of a bigger whole – leaping between details and the whole, or between concrete and abstract [7]. This continuously change of focus is important for the quality of the design. Keeping in mind the purpose of the end-product when designing details ensures consistency, while focus on details ensures solutions to every smaller problem.

Inspired by Hugh Dubberly [1:40] these six questions will be emphasized in this thesis:

- For resource management of paramedics, what is the system?
- What is the environment in which emergency response occurs and what is the relation the system has with its environment?
- What is the feedback provided by the system, both of statuses and errors?
- How does the system measure when it has achieved its goal?
- Who monitors the system?
- Is the system meeting the needs of its users?

These six questions will be answered on two occasions later in this thesis. First, in Chapter 5.3 they will be answered with the system utilized today in mind. Secondly, in Chapter 12 will be answered with respect to the system designed in this thesis.

3.2.1 The ISO 13407 human-centered design lifecycle model

There are many models which tries to completely capture the whole design process [7]. It is important however to understand that a model is a simplification (sometimes over-simplification) of a real-life artifact or process. Knowing this urges any designer to remain critical towards any description of the design process, and keep an open mind towards unexpected turns [7].

There is however a lifecycle model that has inspired the structuring of the design process in this thesis. This model is known as The ISO 13407 human-centered design lifecycle model (See Figure 2) [6].

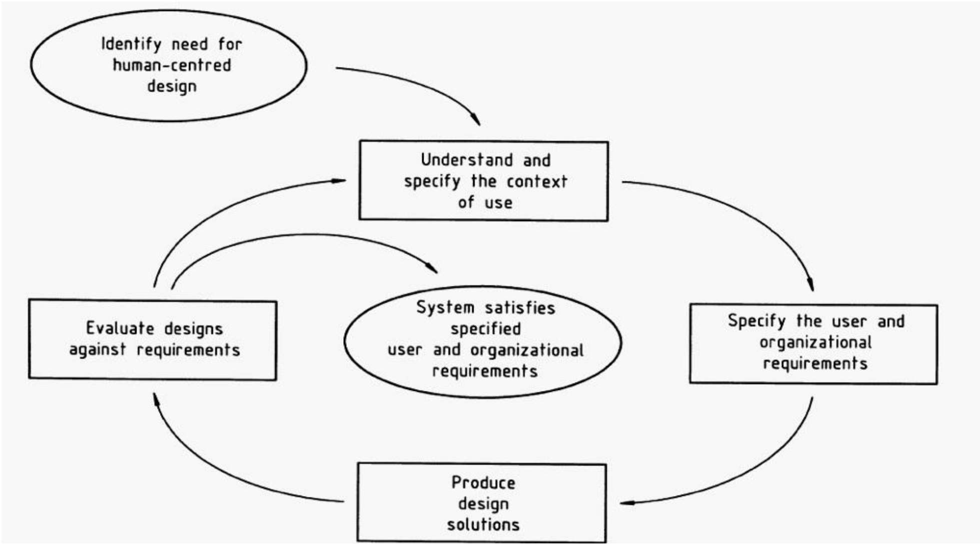


Figure 2 – The ISO 13407 human centered design lifecycle model

The model specifies four design activities as central to a system development project, all human-centered [6]:

1. Understanding and specifying the use context.
2. Specifying the users and organizational requirements.
3. Producing a design solution.
4. Evaluating the design against the requirements

The lifecycle model emphasizes that one should iterate the whole process until the specified user and organizational requirements are met [6]. The reason for this is that evaluations of the design might create new understanding of context and users implying a need for alterations of the specifications defined in point 1 and 2 before a new design should be created and evaluated. Developing a user-centered design is process of negotiation where the designer learns throughout iterative interactions with the users as the design evolves. "*Most experienced designers know one truism: you seldom get it right the first time*" [1:119]. Understanding this as a designer is important for the quality of the end product.

3.2.2 Divergent and convergent phases

The thesis is divided into two major phases: A '*divergent*' phase and a '*convergent*' phase [7]. These two concepts are often mentioned in discussions of design and refer to different approaches during a design process. In the divergent phase the researcher expands his/her thinking "*… to cover broader issues, find more alternatives, and explore more opportunities*" [7:29]. The design process will in this phase revolve around creating more information and options. The aim is to explore what is possible and develop multiple ideas. It is a known problem that designers often 'fall in love' with an idea and wants to defend choosing it instead of trying to find what will actually be the best idea [7]. Avoiding this happening is important to ensure that the design is not governed by the designer's subjectivity but rather by the needs of the users. The start of this thesis had a divergent phase where information was gathered and multiple angles to the problem area explored. Different technologies were explored and many ideas were developed.

Convergence refers to the focus on creating a specific design suggestion or synthesis of several ideas [7]. In every process where the outcome is a solution, a system or a theory, the last part of the process is a convergent one. Here one looks at the information gathered and the possibilities available and uses this information to get a deeper and more detailed understanding of the problem area. Then one narrows the focus and start creating the end-product based on what has been learned [7]. The last phase of this master thesis was mainly convergent.

However, although the design process has been divided into two phases it is important to emphasize that these approaches to information processing often overlap. This is especially true in design processes with an iterative structure like this thesis. The mindset of the researcher often wanders between analyzing the data gathered and finding new information. But it is a useful distinction when describing a design process because it emphasizes the shifting focus from information gathering to information application.

3.3 Philosophical paradigm

There are many ways to conduct research. Underlying assumptions often define what type of data the researcher is looking for. This is often referred to as philosophically differences in research approach [25]. One way of distinguishing between these different philosophical perspectives in qualitative research is the three-fold classification of the positivistic, interpretive and critical paradigms (See Figure 3). Positivists conduct research with the assumption that reality is objectively given, measurable and attempt to increase the predictive understanding of a phenomena [25]. They often believe that data can and should be completely independent of the researcher and his/her instruments.

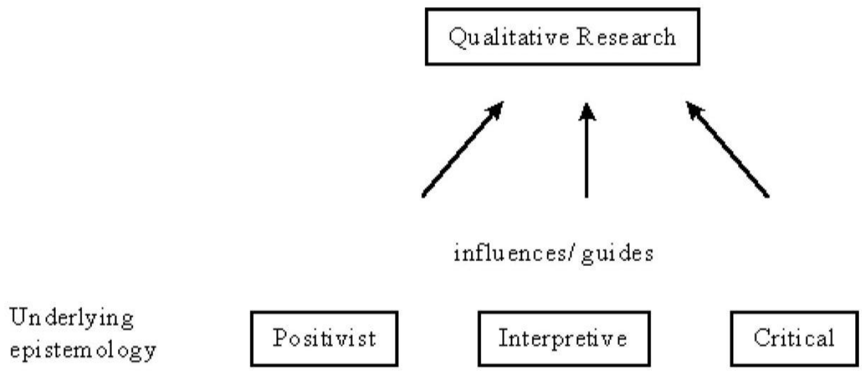


Figure 3 - The three-fold classification of philosophical research paradigms

The pure interpretive researchers on the other hand assume that reality is often too complicated to be measured and predicted. They believe that in order to understand a phenomena one have to look at social constructions such as language, consciousness and meanings that people assign to them [25]. Interpretive researchers view reality through the knowledge of reality, thus perceives it as a social construction by human actors [26]. In this way interpretive researchers focus more on the subjectivity of reality than positivistic researchers do. Additionally many of the interpretive researchers believe, in contrast to many positivistic researchers, that it is impossible for a researcher not to bias the data gathered. "*We are all biased by our own background, knowledge and prejudices to see things in certain ways and not others*." [26:321]. They instead acknowledge that they as researchers are a part of the equation, and try to instead use this when gathering data. One example is through the use of interviews, where the interpretive researcher will try to create a meaningful and more personal conversation to make the interviewee feel as comfortable as possible. A nervous informant might constrain him-/herself from providing information that you as a researcher would value [26].

Both the positivistic and interpretive researchers tend to look for descriptive data. This means that they try to understand and describe the phenomena as accurately as possible, without focusing on how it *should* be [27]. The researchers of the critical paradigm however are generally more prescriptive. They assume that the social reality is historically constructed, and that it is produced and reproduced by people. In their eyes people are constrained by various forms of social, cultural and political domination. They research a phenomena and looks for ways in which it could and should be changed. "*The main task of critical research is seen as being one of social critique*" [25:5].

The research conducted in this master project was carried out within the interpretive paradigm. Keeping within this paradigm enables researchers to get closer into the mindset of the users and to uncover not only what they do, but also why and what they think about it. Knowing this is vital to the development of an IT-system tailored for the users. The prototype in this thesis was designed on the basis of the understanding of human-device interaction as well as of human communication. The users were observed and interviewed, and the data was interpreted by the researcher. Although the research conducted here is regarded as interpretive we should note that the research focus during the design process was of a prescriptive nature: The aim was to improve upon existing technology and routines, i.e. the focus was on how it *should* be instead of just describing how it currently is [27].

3.4 Methodology

This master project implemented qualitative research methods [22]. This means that the research was focused on getting an in depth understanding of a phenomena, and that the available research time was spent on this rather than on getting a more generalizable and wider understanding that quantitative methods would give [22]. It is well known that doing both '*in depth*' qualitative and more 'generalizable' quantitative research together would enhance the quality of the research data by optimizing the '*triangulation*' effect [6]. However, with the limited time available we chose to utilize only qualitative methods. This is not just a matter of time though, the limited access to end users and the interpretive philosophical approach made qualitative methods more suitable for the area to be researched. Quantitative methods would include large surveys combined with statistical analysis of current and previous practices. The surveys would be difficult to conduct due to the limited access to users, and the statistical analysis would be difficult to conduct due to two things. The first is that it is very difficult to record statistical data of paramedics in major incidents because such incidents rarely occur, and when they do they are certainly not planned (At least not by the users themselves). Furthermore if one were to record data during these incidents one would be subjected to a lot of traumatic impressions that could seriously bias the data recorded. The second difficulty with statistical analysis of paramedical work is that of poor logging. The data recorded from previous incidents, such as the Åsta-accident is of poor quality and a lot of the incident experiences has been lost due to the unsatisfactory system for logging incident data [2]. This will be further discussed in Chapter 11.6.

3.4.1 Case study and action research

In the early parts of this master project it was not clear what methodology would be best suitable for investigating the research question. There were two methodologies that both were relevant, but both seemed to be slightly unsatisfactory. These methodologies are known as 'case study' and 'action research'.

Action research – Research action

The research in this master project is conducted in iterations of software development and evaluations with focus on improving the UI and the system for resource management. Taking this into account we see that this research is prescriptive and is centered around a problem; how can the UI and resource management system be improved? On the background of this it is fair to say that Action Research is the methodology in which this research was carried out [22].

However, this research was carried out with emphasis on understanding the users' challenges and needs in a field where acquisition of new knowledge is essential for the success of this project. The term Research Action might therefore be a better term:

- Action Research *"... does not ignore learning but is more appropriate when reliable research evidence is already available but may need to be refined and/or extended. Research Action by contrast emphasizes acquisition of knowledge and applies where social science issues are problematic and need to be explored before change can be useful."*[22:357]

The focus on change however makes research action not completely satisfactory as a methodology in this master project. We were not able to introduce changes to the work routines and equipment of the users and were therefore not able to observe the effects of the suggested changes. The interface on the other hand was iteratively developed through a research action approach. Based on this research action was regarded as a semi-suitable methodology, but not completely.

Preliminary case study

When the research started in this master thesis there was no clear understanding of what the paramedics needed. To understand these needs interviews and observations with paramedics and local administrators was conducted. This is regarded as a '*contextual inquiry'* [7]. In the preliminary stages of research, case studies can often prove valuable. In contrast to pilot surveys and other more generalizable pilot research methods, the study of a single case enables the researchers to dive deeper into the area one is researching more quickly [7].

The observations and interviews conducted during the collaborative training exercise in Stavanger can be considered as a small case study. As explained by Bent Flyvbjerg [28] a case study is a detailed examination of a single example of a broader class or phenomena. In research on information systems (IS) case study is the most commonly used qualitative method [25]. It is particularly well suited to IS research, because "*the boundaries between the phenomenon and context are not clearly evident*" [25:6]. In other words, one does not always know why a system works, or why it fails, and looking at the phenomena in its use context might be the only way to understand why. The data collected from case studies is descriptive and should be treated as specific data related to that single case, and should not be generalized upon uncritically. However, as he argues, that does not mean that it does not provide reliable information about the broader class.

"*Common to all experts*..." Flyvbjerg says, "... *is that they operate on the basis of intimate knowledge of several thousand concrete cases in their areas of expertise.*" [28:222]. He argues that if people in a learning process, which research also is, are only trained in context-independent knowledge and rules – they would remain as beginners throughout the process of learning. "*It is only because of experience with cases that one can at all move from being a beginner to being an expert*." [28:222]. This stresses why case studies can be so valuable to researchers as well as students and professors.

Furthermore, in designing a system for users in always changing environments propose a complicated problem: One does not have the resources it would take to map every possible environment in which the system might be used. Therefore it is important to primarily find out what the most 'normal' user environments are, and additionally look for context-specific environmental traits. Looking at for instance swans we would all agree that they are all white. There is however also some rare black swans. Looking for black swans when designing for a user group is almost as important as making sure that one is not currently just researching a black swan. Case studies provides the tools necessary to discover 'black swans' within a field of research mainly *because* its primary focus is not on what is generalizable but rather on what is case-specific [28].

"One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas "the force of example" is underestimated." [28:228]

This might lead us to ask the question: 'Do we *need* the data in this thesis to be generalizable?' The results of this thesis are a system which has to provide functionality to tackle most of the different cases paramedics encounter. So the short answer would be 'Yes'. It is however important to note that the system is designed for paramedics only, and therefore does not need to be scalable or adaptable beyond the use of paramedics. During this research process there has therefore not been involved other agencies or been any focus on the needs of the open marked. The need for generalizability is therefore limited to paramedical workers only, and by the tasks they perform.

Case studies as a research strategy

"*A case study is not a method but a research strategy*" [22:323]. Much in the same way that the observation and interviews in Stavanger can be said to be a case study, we can also view this thesis as a case study. Throughout the study the data was gathered in smaller sections of a larger whole, and the users that we interview and observe are all representatives of the same broader 'class'.

Generally case studies incorporate multiple research methods in the study of a specific case. This is both to gain a better multi-perspective understanding of a problem and to ensure triangulation of data for the purpose of validity [22]. It is normal to use different techniques for collecting data in a study because every method has their own weaknesses. The combination of different methods ensures that the risk of missing important data because of a single methods 'blind spot', leading to a more rigorous and defensible findings [6].

In this thesis interviews, direct observation in the field and document analysis have all been used to gain thorough understanding of the case area and user context of paramedics in the field. Additionally a *brainstorming session*, *analytical evaluations* and *usability testing* have been used to evaluate and translate the findings into a design [6].

Based on these thoughts the methodology used in this master project is regarded as a mixture of prescriptive research action, with the focus on iteratively changing the way in which things are done now, and descriptive case study, where the focus is constricted to one defined group and/or area of interest.

3.5 Methods for data collecting

Choosing the right methods for collecting data is depending on many factors. Although all methods collect data and all data is useful to some extent, some methods are better than others at gathering specific types of data from specific types of users. Knowing which methods to use in each case can improve the results from the data collection process. When choosing the methods it is important to accept that time is a limited resource and that one, as a researcher, has to spend it as best as possible.

The most commonly used distinction in research methods is that between qualitative and quantitative research [25]. While quantitative research methods were developed to study natural phenomena within natural sciences, qualitative research methods were focused towards social phenomena. One particular strength of qualitative research is its ability to focus on actual practice in its actual context [29]. Qualitative researches often focus on getting deep into a phenomena and understanding it in relation to the environment in which it exists.

The methods used in this thesis are all qualitative; Interviews, direct observation, document analysis and a brainstorming session. In this chapter each of these methods' advantages and disadvantages will be presented shortly and then reasons for choosing the method will be discussed.

In addition each method has been discussed with peer students. Using peers to comment is quick, effective and inexpensive way to ensure that for example the interview guide does not have questions that will unnecessary provoke or disturb the interview subject(s). This is a good substitute for pilot studies in cases where the users are expensive or difficult to involve [6]. Also, nobody who has been asked to comment has been involved in the main study. The reason for this is that it could distort the results [6].

An iterative process of analytical evaluation testing and prototype-design improvement was implemented. In this process both students and end-users was involved. This was partly to gain a better understanding of the users and partly to ensure that development continued to take users' activities into account. Students played the role of users in the testing of aspects of the system where paramedical experience was not required, such as the testing of icon intuitiveness. Involving end-users is, in addition to being the best way to understand what the users need, also a good strategy for expectations management [6]. It generally influences the users attitudes and increases the likeliness that they are positive towards implementing the new technology as they *"are more likely to feel a sense of 'ownership' towards it when it finally merges" [6:419]*. However, this will have more impact in projects where the majority of end users participate in the design process.

Data recording

The methods used in this thesis are performed with multiple data recording techniques. The interviews were audio recorded and later transcribed. Additionally notes were taken to record any extra information provided by body language like facial expressions and gesticulations. Notes were also used during the observation. Here also photographies were taken to document different challenges related to the physical context. Let's elaborate on the techniques used in this thesis.

> **Recording audio**: The advantage of recording for instance an interview is that one can go back and listen to any part of the interview if one wants to investigate new aspects after the interview was conducted. The opportunity of direct citation is also a great aspect of audio recording [26]. Also, since everything that is said is recorded the interviewer has the opportunity to focus more on the interviewee rather than concentrating on writing everything that is being said [6]. The disadvantages of audio recording can be divided into two. First it can easily make the interviewee nervous or uncomfortable because they are not used to be recorded [26]. Second the process of transcribing the interview is very time-consuming. Since the interviews conducted are a part of a larger project it was important that the data from the interview was made available. Audio recording of a person's voice is considered to be sensitive data and it was therefore necessary to transcribe the interview in full so that the interviewees could be kept anonymous. Something one should keep in mind is that"*... tape-recording does not capture the tacit, non-verbal elements of an interview, which are crucial aspects of the experience for the researcher*." [26:323]. This means that whenever one uses audio recording to record data one should supplement it with other recording techniques, like for example taking notes.

> **Taking notes**: Taking notes is a great technique to record unexpected data. It is great for recording thoughts about the interviewees' body language, gestures and facial expressions in addition to recording what is being said. It provides the opportunity for drawing figures, tables or connecting data already written. But note taking is also limited by the speed of writing. Therefore it is important to transcribe the notes after the interview to complete unfinished sentences – thus making it time-consuming. But the biggest disadvantage of taking notes is that it requires a lot of concentration and effort, thus making it more difficult to pay attention to the interviewee

at all times. This can cause the interviewer to miss key points that the interviewee communicates. Being more than one interviewer or combining the note taking with other data collection techniques is therefore recommended [6]. Taking notes by hand is recommended because it is the least obtrusive way to take notes. Laptops, PDAs and other devices can easily distract the interviewee, while handwritten notes are practically invisible [6]. All notes taken during interviews and observations during this master project have been written by hand.

Taking photographs: It is often difficult to describe in words how a physical environment limits or affords certain types of behavior. The expression 'A picture says more than a thousand words' pretty much sums it up. Both as an illustration when writing and as a boundary object in the communication of a case, photographies are of high value [23]. What is important when using photographies in research is that people in the pictures are often highly identifiable. It is therefore important to get permission from identifiable individuals if one wants to use the photo in a published work.

3.5.1 Interviews

Interviews are used in almost all interpretive research as a key way to access the interpretations of different actors in a field [26]. One great aspect of interviews as a research method is that it is a method that participants are familiar with, and therefore feel that it is easier to accept being interviewed [26]. In addition most people like talking about their work, whether it is to share their enthusiasm or to air complaints [22]. The method is also agile meaning that it can change according to the interviewee. This ensures a high degree of *validity*, i.e. the methods ability to measure what it is supposed to measure [6]. The interviewers' ability to make the interviewee feel comfortable and motivated to provide communication is key.

It is however a highly time-consuming method – both for the interviewer and for the interviewee [22, 26]. It is important to keep this in mind when planning interviews with informants, especially if they have a limited time-schedule. Keeping a good reputation amongst potential informants might turn out to be vital in research conducted over a certain period of time [26].

"*The goal of any qualitative research interview is "(…)"… to see the research topic from the perspective of the interviewee, and to understand how and why they come to have this particular perspective*" [22:11]. Differing from quantitative interviews which strives towards minimizing the impact of inter-personal processes between the interviewer and interviewee, "… *the qualitative researcher believes that there can be no such thing as a 'relationship-free' interview*" [22:11]. The qualitative interview becomes more of a conversation between two or more individuals about a certain subject.

There are four main types of interviews: Open-ended , structured, semi-structured and group interviews [6]. Structured interviews are often used in quantitative research, where the data collected from one interview needs to be compared with data from many other similar interviews. Open-ended and semi-structured interviews are more common in qualitative research [22]. In this thesis open-ended and semi-structured group interviews have been used, in addition to a structured interview with an expert on sensor technology from SINTEF.

Structured interviews emphasizes control over the interview process and provide a high degree of *reliability*, i.e. the results of the interview would be the same in separate occasions under the same conditions [6]. Open-ended interviews is good for exploring issues, and allows for more elaboration on new topics that might come up [22], but produce a low level of reliability. Early in the design process it is often uncertain what is of importance when conducting an interview. Therefore open-ended interviews are often used in the divergent part of a design process [6].

The first interview with the paramedics from Oslo was an open-ended group interview. The aim was to get an overview of the perceived challenges of paramedics, and to uncover potential for new technology. Keeping the question open-ended allows the interviewees to talk about what they feel is of importance instead of answering specified questions formulated by the interviewer. This was all conducted in the divergent part of the process, and the interviewees were guided as little as possible.

The second group-interview was semi-structured. It was held right after the observation of the collaborative training exercise in Stavanger, and aimed at investigating why things was done the way they were. The interviewees had little time available, and it was therefore not enough time to allow them to wander off into an unrelated topic. This meant that it was impossible to have a completely open-ended interview. Some of the questions were also closed questions, which gives a shorter "yes or no"-type of answer. However, it was not completely structured. The aim was to understand how the interviewees experienced the training exercise and the different challenges encountered. Therefore many of the questions were formulated to be open-ended, while the interviewer guided the interviewees so that what they talked about would be relevant [6].

The evaluative interview with the Operational Commander was combined with that is a *cognitive jogthrough* [24], which is a fast-paced version of the *cognitive walkthrough* [6]. This method is less structured than the walkthrough and allows for more flexibility during the testing [24]. Another method that was considered is known as '*group-based expert walkthrough'*. This method emphasizes the involvement of users in evaluations and relies on pre-defined structured action sequences. The reason for not choosing this method is rooted in the limited time available with the users. This method was regarded as too time consuming and instead the jogthrough was chosen. It would not be correct to say that the session was a book example of cognitive jogthrough though because it, being a subclass of walkthroughs, are most often conducted without the involvement of users [6]. It is often chosen in cases where the users are unavailable and other evaluation experts have to try and predict how the users would operate the system. In a cognitive jogthrough understanding the users' perspectives is often a large part of the method. In our case the users were available, but only for a limited time. Since the users already have a complete understanding of their own perspective, and are what we call '*work-domain experts' [30],* we could instantly start the jogthrough itself and begin the evaluation.

The limited time-frame also made it impossible to conduct a heuristic evaluation. Conducting a evaluation based on heuristics involves a briefing session, a 1-2 hours independently inspection period and a debriefing session [6]. Choosing to do a more empirical evaluation based on pre-defined heuristics could reduce the chance of biasing the data and would be more likely to produce data with more validity than the method we chose [6]. However, since there was not enough time available with the end user this was not an option we instead chose to combine an interview with a cognitive jogthrough.

When the users interacted with the prototype and evaluated the system they were urged to explain what they thought as they interacted. This technique is known as the *'think aloud'*-technique and is useful for revealing the internal processes that a user bases his/her actions and impressions upon [6]. Solely observing a user interacting with the system would not reveal what they actually think, and one might risk misinterpreting or completely missing major issues with the user experience. It is well known, on the other hand, that users are often unable to explain every thought in detail. This both because they often do not know why they do or think something [6], meaning that the knowledge is *implicit* [16] , and because a lot of this knowledge is *tacit* [14], meaning that the users are unable to verbally share it with others. One should therefore also pay attention when observing and not solely rely on what is being said.

The session was supplemented by questions that arose depending on what aspects of the system the OC focused on. It was not possible to determine which aspects this would be prior to the interview. The interview was explorative and mainly open-ended [22]. There were however some aspects of the design and of the system which was of a specific interest for the researcher meaning that some questions were pre-defined. An example of this was the question of the intuitiveness of the icons and to what extent the system would reduce the strain on the radio communication. This interview is therefore defined as semi-structured [22].

3.5.2 Direct observation

"*Observing actual work gives insights that other techniques can't give*" [6:343]. To understand the context of the user in the natural work environment direct observation is a preferred method. It allows the researcher to see what is actually done instead of just learning what people think they do or say they do. The method is a great way to understand the wide use context and is often applied in the divergent phase of the process [7], as was the case in this master thesis. Another thing that supports the use of observations is the appropriation of tacit knowledge. Since methods like document analysis, questionnaires and interviews only reveal explicit knowledge one runs a high risk of missing key information should one implement these methods only.

Observation is however very time-consuming [6]. Detailed arrangements have to be made and the participants have to agree to being observed. The researcher has to develop a good observation guide so that it is easier to keep focus on what one wish to observe. Additionally the researcher has to physically be there to observe, take notes, pictures or use other data collecting techniques. Afterwards everything has to be analyzed, organized and transcribed.

The observation technique used in Stavanger was a direct observation of the users' natural environment, as a passive observer. This means that I was at the scene observing the participants in action, but that I did not participate in any way [6]. We as observers wore blue wests that the participants knew meant that we should be ignored, and we tried to position ourselves in unobtrusive locations where nobody would want to, or need to go. The reason for calling the environment natural although it was a training exercise is that the participants themselves did not know beforehand that it was a training exercise.

When observing in Stavanger I was inspired by Colin Robsons observation framework as described in [6:325]. His framework encourages researchers to pay greater attention to the context of the activity. The framework consists of looking for:

- What is the physical space like?
- What are the details of the different actors?
- What are the actors doing, and why?
- What physical objects are present?
- Are there any individual actions?
- Is there any special events occurring?
- What is the sequence of events?
- What are the actors trying to accomplish?
- What is the mood of the group and of individuals?

After conducting the observation however I must admit that trying to observe with all of these questions in mind was very difficult, and I am sure that I did not see all that happened there. However, having a framework like this really kept me focused on the task of observing and on looking for anything relevant to the research. Therefore I really see the value of a thorough framework while observing, and I would recommend this framework to anyone.

3.5.3 Questionnaire

During the course of this master thesis one questionnaire was conducted to test a certain aspect of the design. The reason for using a questionnaire was to reveal how 'most people' interpreted the meaning of different colors in the interface (The results are presented in Chapter 6.2.1). The questions were of a closed nature so that they would be easier to compare, and the results were put into a table. In designing a questionnaire it is imperative that the questions are created in a way that eliminates the possibility of misunderstanding the questions. This is because the researcher will not be able to explain to the respondent if anything is unclear, as is possible in for example interviews.

3.5.4 Brainstorming as a method

Although most people have heard about the technique of brainstorming it is not as common to actually use it to its full potential [7]. This was however done with success in this master thesis both to discuss the system and the interface suggested here, but mainly to create new icons to be used in the interface (The implementation and findings from the brainstorming session are described in Chapter 7). A brainstorming session normally involves three to seven participants. In this master thesis there were four students involved. The group was gathered based on their background. Two of the participants were master students within interaction design seen as experts within the field. One of these also has experience with graphical design. The third participant writes a master thesis within IT management and can be seen as an expert within this field. The fourth participant was a programming student which emphasized the practical coding aspect of the system. The different backgrounds ensured lively and fertile discussions amongst the participants.

A brainstorming sessions should have a generating phase and a structuring phase. In the generating phase it is not allowed with criticism. Every idea should be considered a good idea and even crazy ideas should be welcomed. The ideas are written down, and new ideas are encouraged. Discussion, criticism and analysis come later. The idea of this phase is that participants should be inspired by the ideas of others and be unafraid to share them aloud with the others [7]. After the divergent idea-phase, which normally continues until the energy level begins to wane, the convergent structuring phase begins. In this phase every idea is grouped into categories and then discussed. Here criticism is welcomed and unsatisfactory ideas removed.

The goal of a brainstorming session can differ. Early in a design process divergence is emphasized and the goal is often to gather as many ideas as possible and process these ideas through the use of other methods. Later in a design process however convergence is emphasized and one wish to find solutions from the multitude of possibilities. In these cases the brainstorming session can have a more thorough structuring phase. This was the case in the brainstorming session conducted in this master thesis. It was conducted late in the convergent part of the design process and aimed at getting a concrete suggestion of icon design.

3.5.5 Prototyping

The use of prototypes enables the designer to communicate freely with the user-group. The mind-set of any person is a result of subjectively interpreted experiences, and the way in which one communicates as well as interprets new experiences is highly subjective. Therefore having a *boundary object* that the designer and user can refer to when communicating is important to ensure that everybody talks about the same thing [23]. Many clients will have great problems understanding or visualizing a design until they are presented with a prototype. Prototypes are therefore mainly a tool for communicating [1].

As Gitta Salomon, a consultant interaction designer puts it*: "One of the biggest challenges is remembering that half of what we do is the design work, and the other half is the communication of that design work. The clients almost never bridge the gap for us: we need to bridge it. […] We'll make an artifact, which allows them to say "Yes, it is like that" or "No, it's not like that, it's like this…." Without something to point to they couldn't even say to each other "No, that's not what I mean" because they didn't know if they were talking about the same thing." [6]*.

The purpose of a prototype other than being a communicational tool is to test certain aspects of a design. "*As much as designers like to think so, they aren't all knowing and all seeing*." [1:25]. Sometimes a prototype will be created to see if one is on 'the right track', other times multiple versions of a design will be presented to see what works best, and what should be altered [1]. Horst Rittel concluded in the early 1970s that *"…design is best understood as negotiation. There is no "right" solution, only a number of more or less good solutions supported by more or less good arguments.*"[7:93]. Good arguments are developed when arguing with other individuals and when evaluating the design with its users. Finding a good solution is, based on these theories, more likely when using prototypes as a communicational tool.

Three types of prototypes

In interaction design one usually work with three types of prototypes: *paper*, *digital* and *physical* [1].

Paper prototypes are simply illustrations and drawings of different design suggestions. They are usually regarded as the fastest way to demonstrate a design. Although they might seem very simple and far from the end-result, they are in fact a great mean in the communication with the users. It is possible to bend and fold paper, and the participants in the testing are able to draw and write directly on the prototype itself. It is often detailed enough for the users to understand the concept of the design, but also evident to not be the final design. This is a point that is interesting when discussing prototypes: Having a too detailed and 'good looking' prototype might actually cause the users to provide less constructive criticism than having an obviously faulty one. This is because participants tend to regard for example digital graphically well designed prototypes as the final product – thus stopping them from thinking about alternative design solutions [1].

But the low-fidelity paper-based prototypes have their limitations, and sometimes one has to use digital or physical prototypes instead. These often high-fidelity prototypes are more time-consuming to create and, as discussed above, might limit the feedback given by the users by being too advanced [1]. Prototype testing on users is often referred to as user testing [1].

In this thesis both high-, and low-fidelity prototypes was used; Low-fidelity paper-based prototypes in the brainstorming session, and a high-fidelity working digital prototype developed in Android on a physical device in the evaluation with an Operational Commander.

3.6 Evaluation approaches

Testing and evaluating a system is important to ensure that it will meet the requirements and needs of its users. Even though every individual can reflect upon how a user might want something to be it is not always as easy to accurately define this without involving users. Every person is predisposed to approach and encode problems in different ways due to the different *mental models* individuals have [4, 16]. Both users and designers are *biased* by their own perspectives and mindsets [6]. We have also mentioned the issue of designers that often fall in love with a specific idea before every possibility has been explored. These are some of the reasons for why it is so important to test the system involving other individuals and users. Furthermore there is the problem of '*functional fixedness*' [16]: - Designers are often blinded by the idea of how the system is meant to be used, and are therefore prone to overlooking other possible uses. Involving other persons will often surprise the designer by uncovering new possibilities and problems that had otherwisely been completely unnoticed.

There are three main evaluation approaches. These are usability testing, field studies and analytical evaluation [6]. These approaches are associated with several methods. The main groups of methods are observing users, asking users and modeling users' performance [6], i.e. predicting how the users would perform based on what is known about them and their environments.

Although the advantage of field studies is obvious; a high degree of realism in the results of the evaluations, it is highly time-consuming and often complex. Due to the limited time-frame of the master program we were unable to implement this evaluation approach. Ideally the system should be implemented in full scale testing where Operational Commanders and emergency personnel could try out the electronic tags and the mobile devices' interfaces in a natural work setting. Testing the system in the users natural environment would ensure a high degree of *ecological validity* which is difficult to achieve with other approaches [6]. Due to the complexity of organizing larger emergency incident training exercises we were not able to test the system through the use of this approach. Furthermore, to be able to test this system realistically the electronic tags would have to be created and the software needed would have to be developed for the intercommunication of the devices enabling the real-time overview of the operational area.

The other approaches were however utilized. Analytical evaluations were used because they are less time-consuming than field studies and usability testing. It is however considered to be less valid than the other more user-centered approaches [6]. Considering this the analytical evaluation of the system was combined with usability testing ensuring a broader understanding of the efficacy of the suggested system and design [6].

3.6.1 Analytical evaluation

One of the reasons for choosing to do analytical evaluations during the course of this master thesis is the limited access to end-users. There are two categories of analytical evaluation: Inspections and theoretically based models [6]. Inspections include heuristic evaluation and walkthroughs, where the latter one has been used in this master thesis. Theoretically based models use theories and previously acquired knowledge to predict user performance.

The walkthrough technique used in this master thesis is already discussed in '*3.5.1 Interviews*' and is called '*cognitive jogthrough*. It involves guiding users, or user-substitutes, through a simulated user's problem-solving process and checking how they progress. This technique was combined with the *think-aloud* technique where users are asked to explain what they do and why they do it as they are interacting with the system/prototype/product [6]. The users were further encouraged to express any problems or possibilities that might arise during the evaluation. This was done both as a part of the brainstorming session and with peers in the second prototype evaluation (See Chapter 7 and Chapter 9).

In addition to involving peers into analytical evaluations of the system, the designer himself also evaluated the system analytically – mainly based on the domain knowledge that had been acquired. The evaluations were often theoretically based and were made on the prediction of how the users would respond to the problem or solution being evaluated. The decision to use a color-based priority scale for example was a result of predicting the user performance on the basis of what we know about their work. Although making decisions with little or no user involvement is criticizable, the designers mind should not be removed from the decision making in, and the evaluation of the system being designed.

"*I generate more organized sets of themes and issues after a group of interviews or a major field visit. I then try to think about what I have learnt so far from my field data. If this sounds a rather subjective and relatively unplanned process, well it is. I believe that the researcher's best tool for analysis is his or her own mind, supplemented by the minds of others when work and ideas are exposed to them*." [26:325]

Opportunistic evaluations

The exposure of ideas to the mind of others is, as discussed earlier in this master thesis and as commented in the quote above, very important. Many evaluation techniques are highly time-consuming and can be difficult to implement. In some cases larger evaluations is needed, but in many cases there is little need for massive procedures. This is for example true for evaluating small design decisions and ideas. The main advantage to opportunistic evaluations is that it is a great way to get quick feedback about a design idea and it requires little resources [6]. It simply involves asking whoever is available and eligible to answer for feedback about a certain feature, idea or decision, and is often used early in design processes where the number of ideas are high and the resources available makes it impossible to conduct larger studies of every idea [6]. This means that little planning is required and that it can be done very quickly whenever an issue arises.

3.6.2 Usability testing

It was important to also involve end-users in the evaluation of the suggested system to test the efficacy of the system and prototype interface. Although the designer and other individuals often are able to understand and predict how users would think they can also often be wrong. The only way to ensure that the users *actually* think and *actually* do one has to involve the users themselves. This is why the usability testing approach was chosen for the last evaluation in this master thesis (See Chapter 9).

Usability testing involves measuring users' performance and satisfaction on typical tasks. "*It is the product being tested rather than the user*" [6:646]. The primary goal of usability testing is to test whether the system being developed could be used to achieve the task(s) which it was designed to do. To ensure the validity of the results it is important that it is the end-users that perform this testing because it is they who are the work domain experts.

The users, an Operational Commander and a paramedical trainee, were asked to interact with the system and perform specific tasks and were then observed by the researcher. They were additionally encouraged to '*think aloud' [6]* and to provide feedback on both details and the conceptual model of the system whenever they thought of anything particular. The session lasted for one and a half hour. Results from the usability testing can be found in Chapter 9.

4 Designing for interaction

In this chapter the theoretical framework for design used in this master thesis is presented. The framework is strongly inspired by Donald A. Norman.

Designing a user interface is closely connected with interaction design. In fact it is so closely connected that many believe that they are the same thing. But interaction design is more than just designing an interface. “*Interface design is only the experienced representation of the interaction design, not the interaction design itself.*” [1:122].

So what constitutes good interaction design? This is a question that has no single answer or clear definition. Any answer to this question is specified by its context, and needs to be considered in relation to its use and its purpose [7]. It has to be judged in relation to user satisfaction and how well it does what it is supposed to do. When designing a system it is important that one understands which property of the system is most important for the users. Is it that it is fun to use, or is it that it performs a task quickly and efficient? Is it important that it has many functions, or is it of greater importance that the system is easy to learn? These are all questions of usability, and highlight the need to be specific as to what aspect of usability is of greater value from the user’s perspective. Knowing this enables us to define goals of usability.

4.1 Usability goals

As suggested in [6] usability can be broken down into six different goals. Although these goals are not conflicting, focusing on some of these goals might force the designer to compromise on others. It is therefore important for the designer(s) to keep in mind which usability goals to prioritize, and which come second when making design choices. The six goals are [6]:

Effectiveness	Defines how good a product is doing what it is supposed to do.
Efficiency	Refers to how quickly and efficient a user can perform their task(s).
Safety	Have three aspects to it. One aspect is protecting the user from danger. The second aspect is preventing the user from causing undesirable situations, like for example helping the user from unwanted deleting of important files. The third aspect refers to the perceived

fears users might have of making errors, and how this affects their actions. Safety is often accomplished through ‘undo-buttons’ and constraints.

Utility	Is the extent to which the product provides the right kind of functionality, enabling the user(s) to perform whatever task or task they need or want to do.
Learnability	Refers to how easy it is to learn how to use the product. Generally users accept using more time learning a complicated product than a simple one. Still, many users won’t bother to use even an excellent product, regarding the 5 other usability goals, if the system is too difficult to learn.
Memorability	Is defined by how easy it is for the user to remember how to use the product once the user has learned how to operate it. This is important if the product is used infrequently. If operations to be learned are obscure, illogical or poorly sequenced it will be harder to remember how to operate the system after a while. Sensible structures and logic are important aspects, as storage and retrieval of information is easier when the material makes sense. This is because when things make sense and are not chaotic or random, they correspond to knowledge that users already have, making it easier to understand, interpret and integrate with previously acquired knowledge [4].

Since paramedics operate in a work environment where time is scarce efficiency will be made top priority in this research. If users remember how to use a system after they have used it one time will also help reduce the amount of time spent on using the program. Memorability will therefore also be emphasized, especially since the system designed in this thesis’ full potential will only be used in major incidents which rarely occur. If users do not remember how to operate the system or if it is the first time a user encounters the system it is important that he or she quickly understands how to use the system. This is why also learnability is a design principle that is prioritized. Another important aspect to learnability however, is that it reduces the need for training. Teaching users to operate a system would be a considerable expense and it in emergency response there is a general inhibition from purchasing equipment that requires training due to the extra expenses that follows.

The other principles is also of great importance, but will not be emphasized at the expense of efficiency, memorability or learnability.

4.2 Design principles

As this master thesis was concerned with the designing of a UI for paramedics operating in the field the main focus was on usability challenges. Meeting these challenges required knowledge about how different designs invoke different behaviors. There are many theories on design, and many principles suggested by different people.

This thesis was greatly influenced by the theories and principles of Donald A. Norman. In his book, *The Design of Everyday Things [4]*, Norman describes a number of different principles of design. These principles are not dictations on how to design the perfect artifact or system, but are rather intended to help designers explain and improve their designs. They are *"... derived from a mix of theory-based knowledge, experience, and common sense." [6]*.

When paramedics arrive at a scene it is often complex and stressful. Time is essential and it is therefore important to focus on a UI design that will enhance efficiency [4, 6, 10]. It is a well known problem amongst designers that too many features in a user interface makes products visually cluttered. This is a phenomena which is known as 'creeping featurism' [31]. Too many features reduce the products efficiency and increases the workload posed upon the user. Fewer features require less consideration for the operator, and one should therefore limit features to a minimum. Too few however will reduce the possibilities and aids that the system might offer. Therefore testing was conducted to find out how to compromise between too few and too many choices.

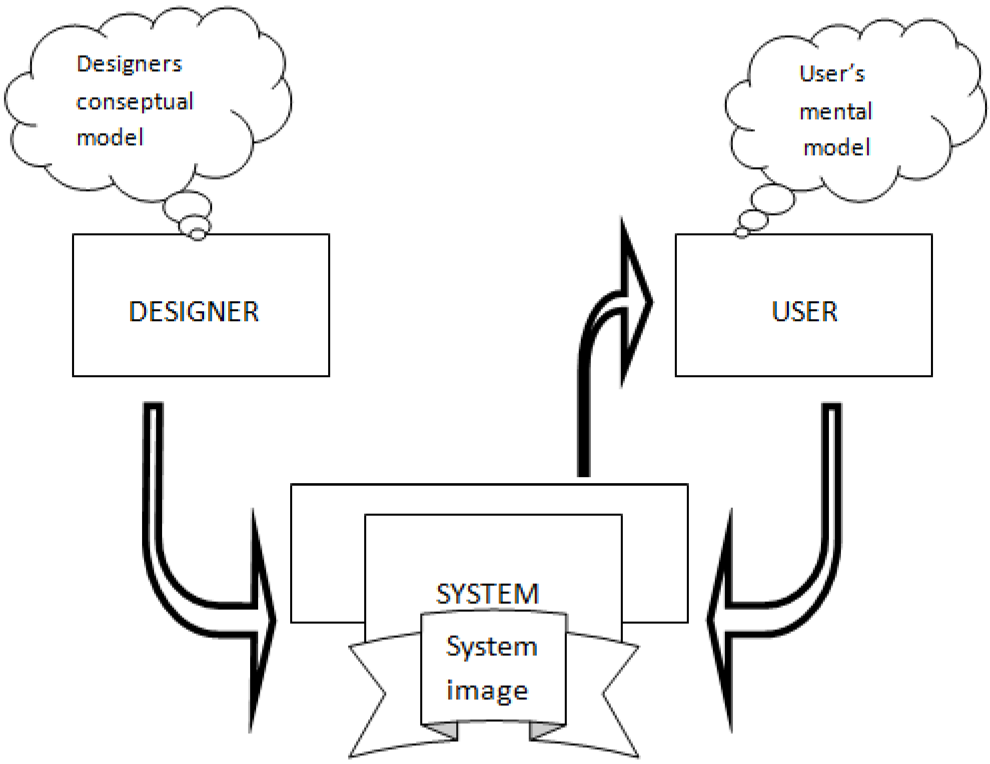
4.2.1 Normans design principles

Norman presents two fundamental principles of designing for people:

1. Provide a good *conceptual model*
2. Make things *visible*

"*A conceptual model is an outline of what people can do with a product and what concepts are needed to understand how to interact with it"* [6:540]. A good conceptual model makes it possible for the user to correctly predict the effects of his/her actions [4]. If the conceptual model is flawed, poor or non-existing, the user is left with a guessing game which soon will lead to frustration, error making, and abandonment. It is critical for the design of the system in this thesis that the users understand how the system works, and what it can do for them. Because paramedics often work in stressful and complex situations it is important that the users know how to operate the system, and how it may help them. A good conceptual model is essential for the success of the system designed in this thesis.

To design a good conceptual model it is important to understand the user. Every user is inflicted by their own mental sets [16], also referred to as '*mental models'* [4]. Mental models are formed through experience, and may be altered and shaped through training and instructions [4]. Knowing the mental models of the users will enable us to design for their way of thinking. Based on the difference in background, both educationally and in types of experiences, the mental model of the designer is often different from that of the users. Since mental models are a result of past experience, and experience consists of both explicit and tacit knowledge, the only way the designer will understand the users' mental models is through experiencing the users' interaction with the system. The user doesn't know the whole system like the designer, and only sees what Norman refers to as the '*System image'* – the visible part of the system [4] (See Figure 4). Using prototypes as boundary objects [23] to communicate the system image to users is therefore a great strategy to ensure that misunderstandings of the system is kept to a minimum.



The designer expects the user's mental model to be identical to the designers conseptual model. But the designer doesn't talk directly with the user – all communication takes place through the system image. If the system image is not clear and consistent, then the user will end up with the wrong mental model. (Norman 2002:16)

Figure 4 – Norman's model illustrating user-designer communication through a *'System image'*

Making things visible, as Norman describes it, also help the user forming the right mental model on how the system works. Therefore the focus on making things visible does affect the conceptual model. Good visibility of possible actions makes it easier for the user to determine what action to choose, thus reduces the users interaction time with the system.

There are three main components to making things visible; affordances, constraints and mapping [4].

Affordances

The system need to be easy to understand, and quick to use. Therefore it is important to consider what affordances it should project. *".. the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used"* [4:9]. Good affordance enables the user to know how the system should and could be used just by looking at it. Simple things should not need pictures, labels or instructions to be used. More advanced things should limit the use of pictures, labels and instructions to the absolute minimum. This can be accomplished through taking advantage of what the user already knows. For example; plates are for pushing, switches have two options (Most often on/off) and wheels can be turned. This should be emphasized when designing menus, buttons and general displays, in software as in hardware. Since good affordances limit explanations to a minimum, and therefore enhances effectiveness and learnability [4].

Constraints

Constraints limit the possible actions to a minimum. This makes the system easier to use, as well as more efficient. Norman mentions four different classes of constraints: *Physical, semantic, cultural* and *logical [4].*

Physical constraints restrict the physical number of choices. Too many physical choices not only makes the system more time-consuming, it also risks causing what is known as cognitive overload – the user feels, just by looking at the system, that there are too many options to consider and therefore resigning before even trying [17]. In design it is normal to refer to '*The Magical Number Seven'* [1, 16]. This is a rule that developed in 1956 by the Princeton University psychology professor George Miller. The rule says that "*…the human mind is best able to remember information in chuncks of seven items, "plus or minus two*"." [1:54].

Semantic constraints rely on the users' knowledge of the situation and the world, while cultural constraints are the limitations provided by what are generally accepted and normal actions within a culture. Since the system is designed for paramedics only, knowing what they emphasize when making their choices is vital for a good design. The general culture of what one should do in any given situation might also inflict the users' interaction with the system. Again, the need for prototype-testing becomes evident.

Logical constraints rely on the user's ability to reason. This is a very powerful constraint, as the user actually will understand why he or she chooses to do what he or she does. This means that the users better remember and recall what they did last time, and that the system is more thoroughly learned [4]. Logical constraints are on the other hand time consuming, and too much consideration amongst paramedical personnel might have fatal consequences. This means that when designing icons one should choose simple symbols and colors that are logically interpreted by the users as what they represent.

Mapping

Mapping *"... is a technical term meaning the relationship between two things, in this case between the controls and their movements and the results in the world."* [4:23]. Good mapping makes a system easy to learn and remember. Taking advantage of affordances, constraints and cultural standards one is able to design a system with a mapping which makes it immediately understood by the users.

Achieving good mapping will also help reduce reaction time. This is confirmed by what is known as Hick's Law [1]: The number of choices influence the time it takes for a user to make a decision. It further explains that grouping choices makes it easier for users to skip what they do not need to consider at that moment. People don't consider a group of possible choices one by one. When designing for users who are dependent on low RT grouping is one technique one should use.

4.2.2 Feedback

Knowing the results of your actions is also a vital part of the user experience. In the way mapping, conceptual model, mental models and affordances affects the expectancies of what result the action provokes, good feedback affects the user's experience of what the result of the action was. Good feedback presents the user with confirmation of what has actually happened.

If there is no feedback the user easily gets confused and uncertain that anything has happened at all. Often the users will end up with doing the same action over and over again until feedback is presented [1], or until frustration takes over [4]. Designing the correct feedback for each action is an important part of the systems success. Wrong feedback is just as bad as no feedback at all. Imagine doing an action correct and in the next second looking at a red 'X'-sign (See Figure 5).

Figure 5
– A red 'X'-sign

Generally users interpret something that happens right after an action to be caused by that action. If a user for example opens a program on their computer and the next second a blue screen appears, the user will think that there is a connection – even if there is none – resulting in the user never opening that program again. To prevent this false causality it is important that when designing the feedback it is obvious what action the feedback refers to. There are various kinds of feedback available in interaction design – audio, tactile, verbal, visual, as well as any combination of these. Using the right feedback for any action might be the difference between success and failure of any system [6].

4.2.3 Consistency

When designing interfaces the focus on consistency will greatly enhance efficiency, safety, learnability, and memorability. If a system is designed consistent, with similar operations and similar elements for achieving similar tasks, the user will be able to identify patterns and also quickly eliminate unwanted actions because of unsimilar appearance on the operational elements. Inconsistency in the interface design implies arbitrariness, making it difficult for users to remember how to operate the system. It also makes the users prone to make errors, both description errors, associative errors and mode errors [4].

Inconsistency can, on the other hand, be used as a tool to divide larger and more complex systems into smaller more manageable sizes for the users. This can make the system more difficult and time consuming to learn, but can in the long run make it easier to use [6].

4.3 Buttons

Choosing a good size for buttons on touch screen interfaces can make a huge difference for the users operating the system. If one makes the buttons too small the users might find it hard to accurately press them. If one makes the buttons too big the screen might be filled up leaving little space for informational displaying. In addition to the question of space there is also the question of reaction time (RT). Smaller buttons are more difficult to press, and the users will use more time pressing small buttons than big ones. Already in 1954 the American psychologist published what is later known as Fitts' Law. This has become one of the few central laws within interaction design. It simply states that there are two factors that affect the time it takes to move from one point to another: The distance to the object one wish to point at and the size of that object [1]. Based on Fitts' Law we can say that RT is reduced when the size of buttons are larger. Keeping in mind that the system designed in this thesis is for users operating in a stressful and time-limited environment, short RT and accuracy is very important. This means that there is a trade-off between limiting the amount of space for displaying purposes – therefore keeping the button sizes at a minimum, vs. cutting down the RT of the users operating the system by enlarging the buttons.

In their paper Sun, Plocher and Qu [32] investigated four factors on operators' performance with touch screens: Button size, spacing between buttons, icon types and implications of users wearing gloves. The study was conducted amongst firefighters, a user group not unlike paramedics. Interestingly spacing between buttons did not affect the users' performance, neither did glove wearing. The users did however think that wearing gloves affected the performance, although the empirical data contradicted this subjective impression. The users were quicker to identify buttons with numbers instead of advanced icons. When it comes to button sizes the researchers found that buttons equal to, or bigger than 40*40 pixels had the fastest RT and the highest percentage of correct responses – 98%. Discussing the trade-off between available screen space and optimal button sizes the researchers recommend that *"...designers should attempt to maintain button size at a minimum of 30*30 pixels in favour of tradeoffs in spacing between buttons, which will have much less impact on performance than reducing button size." [32].*

5 Findings from the contextual inquiry

In this chapter we will present the data that was collected prior to the start of the design process. The data here can be considered to be the findings of the '*contextual inquiry*' (See Chapter 1.2 for definition).

The focus of both the observation in Stavanger and the interviews in Stavanger and Oslo was to understand the users' perspective when operating in the field. The interviews aimed at uncovering what the users perceived as problems and challenges. The observation aimed at finding out what was actually done, looking for potential problems or challenges that had not yet been uncovered through the interviews. There is often a mismatch between what users say, and in fact think they do, and what they actually do [6].

5.1 Findings from the first interview

The theme of the first interview was on how the users operate in daily situations, what they perceived as challenging and what they thought could be done better through implementing new technology. It was conducted in Oslo by Erik G. Nilsson and Mads Helno Jahren, and the interviewees were two experienced paramedical workers, who both had been working decades as paramedics. The interview lasted for two hours, and has been transcribed (See Appendix 2 for interview guide and Appendix 3 for transcription). The issues uncovered are discussed in this chapter.

5.1.1 Communication

Communication between paramedical personnel at a scene is normally verbally and through body-language. Here the use of radio is very limited. The main reason for this is that the radio is a one-to-all communicational tool, and that most of the information that paramedics need to communicate is not of value to everybody who listens to the radio. Not being able to define who the information goes to would result in everyone hearing every message delivered, and the net would quickly be over-crowded. Since the radio only allows one person to speak at a time everyone else has to wait until the previous conversation is over until they can start their own. Furthermore the radio does not supply a queuing function, so that everyone would have to "fight" to be the next one "grabbing the microphone". Also, since paramedics perform time-limited work, the extra wait could ultimately mean the difference between life and death for a patient waiting to be helped.

The interviewees regard the verbally and body-language based communication as being inadequate. It is both severely limited when it comes to distance, noise and visibility. Paramedics often operate in noisy surroundings, i.e. on a highway with a lot of traffic and in cooperation with medical helicopters. There is sometimes reduced visibility, i.e. because of snow, rain, fog or smoke. And the distances between paramedics can often become too vast for normal communication, i.e. when one of the paramedics have to run to the ambulance to get some extra equipment. These factors often limit the paramedics' ability to cooperate and pose a communicational challenge, especially in major incidents.

Communication between the ambulance and the hospitals are sometimes through radio, but mostly through the use of cell phones. This is because of the convenience posed by cell phone technology; there is almost always signal, it is quick and easy to use, and it is only between two phones.

The interviewees also mentioned that the communication between the paramedics inside the ambulance when they are transporting patients is unsatisfactory. In these situations one paramedic is driving the ambulance, and one is in the back with the patient. Due to the engine-roar and the sirens they have to yell back and forth to convey information. This is something they feel might upset the patient and is something they would like to be improved.

The need for a better kind of communication that does not only rely on verbal communication, radio and body language lays some of the foundation for the system designed in this thesis.

5.1.2 Color status code

Accurately communicating a patient's status is important. When a patient is transported to a hospital the hospital need to know what to prepare for. Since every person has their own way of communicating, i.e. someone exaggerates and someone does not, there is a need for standardized patient status language. Meeting this need is the patient status color code system. It is basically a code system divided into 4 categories: Green, Yellow, Red, and Black. This is what the colors signify:

- Green: The patient is practically unharmed and has the lowest priority.
- Yellow: The patient is injured, but stable.
- Red: The patient is critically injured and in imminent need of help.
- Black: The patient is dead or alive but cannot be saved.

These codes are also sometimes used by AMK to communicate the importance of a mission. Code red then means that the paramedics should cancel their current mission and prioritize the "red" one if able. The paramedics also use the code "red" when communicating that they have a critically wounded patient. In these cases the hospital makes this patient the top-priority and prepares the emergency room for the upcoming case.

Since it is only doctors that can actually classify someone as dead there might be a need for another color than black indicating that the patient is assumed dead, but that it has not been confirmed yet by a doctor. This color could for example be blue.

Based on this information the use of these colors to visualize priority has been utilized in this master thesis. The colors were tested and found to be quite intuitive. The color blue was however regarded as a poor color to use since it reminded users of the police instead of a patient. Therefore it was changed to gray, as is explained in Chapter 7.

5.1.3 Small and major incidents

The interviewees made an important distinction between what they there defined as 'type 1' and 'type 2' incidents. In this thesis however the distinction 'smaller incidents' and 'major incidents' will be used, and is briefly described here:

- Smaller incidents: Incidents where the paramedics have the capacity to start transporting patients right away. This implies that there are enough paramedical personnel, enough ambulances and that no patients have to wait for another transport to arrive.

- Major incidents: Incidents where the number of injured patients exceed the number of transports and/or personnel available. In these scenarios paramedics establish a site for life-sustaining treatment. Permanent treatment is not something that will be emphasized outside hospitals, due to both hygiene, lack of time as well as lack of medical education amongst paramedics.

5.1.4 Smaller incidents - How paramedics operate on daily missions

Normally there are two paramedics in an ambulance. Sometimes, however, there are 3. Either because they have a paramedical trainee, or because it is supplemented with a doctor, what the interviewees called a doctor-ambulance.

Generally paramedics do not perform treatment on patients in the field. Their main focus is logistical, meaning that they focus on getting every treatment-needing patient to the nearest hospital as quickly as possible. The treatment given by paramedics is, as they say, just to keep the patient alive and preventing the patients medical status from getting worse. They perform life-sustaining treatment, not permanent treatment.

The interviewees classify paramedical task into three faces:

1. Diagnostically tasks – Locating the patient, checking the patient's status and diagnosing what's wrong, and what should be done about it.

2. Therapeutic tasks – Performing life-sustaining tasks on the patient(s) according to the diagnose.

3. Logistical tasks – transporting the patient to the nearest hospital, emergency or other medical facility.

Most missions consist of very little diagnostic and therapeutic tasks, and are merely just a logistical task: Getting a patient from one institution to another. In these cases they receive the order through a system installed in the ambulances, and they confirm or decline through the system. When the mission is completed they also report this through the system and thereby report that they are ready for the next mission.

5.1.5 Major incidents

As defined earlier major incidents are characterized by having more injured patients at a scene than the emergency personnel have capacity to help and transport at once [9]. This means that there is a need to get an overview and to find out how to manage resources and which patients to prioritize first. In these scenarios the first paramedic at the scene will perform what is known as a "*triage*". This means going through the scene and quickly counting and assessing every patient's medical status in the area before conveying this to the Operational Commander of the paramedics at the scene, which then again delegates every resource available. If there is no Operational Commander present the person doing the triage will delegate the resources. All information of patients' position and status, as well as delegation and resource management is done verbally through the radio or face-to-face.

The person doing the triage brings specially designed slips which he/she attaches to every patient. The triager fills in by hand any information gathered about the patient to the slip, and defines a priority level. The priority level is defined by removing all levels of priority below on the slip, e.g. if a patient is given the third lowest priority status yellow, lower status green is removed from the slip so that the yellow part is at the bottom of the slip. This can again be removed for a higher priority. If red is removed the patient will have priority 'black', which is regarded as the lowest priority. (See Figure 6). The color codes have already been explained under the title "*Color status code*". The triager then hangs the tag around the neck of the patient. The problem with these slips becomes obvious if one wishes to redefine a patient's priority level to a color that has been torn off. It is not physically possible with these paper-based slips.

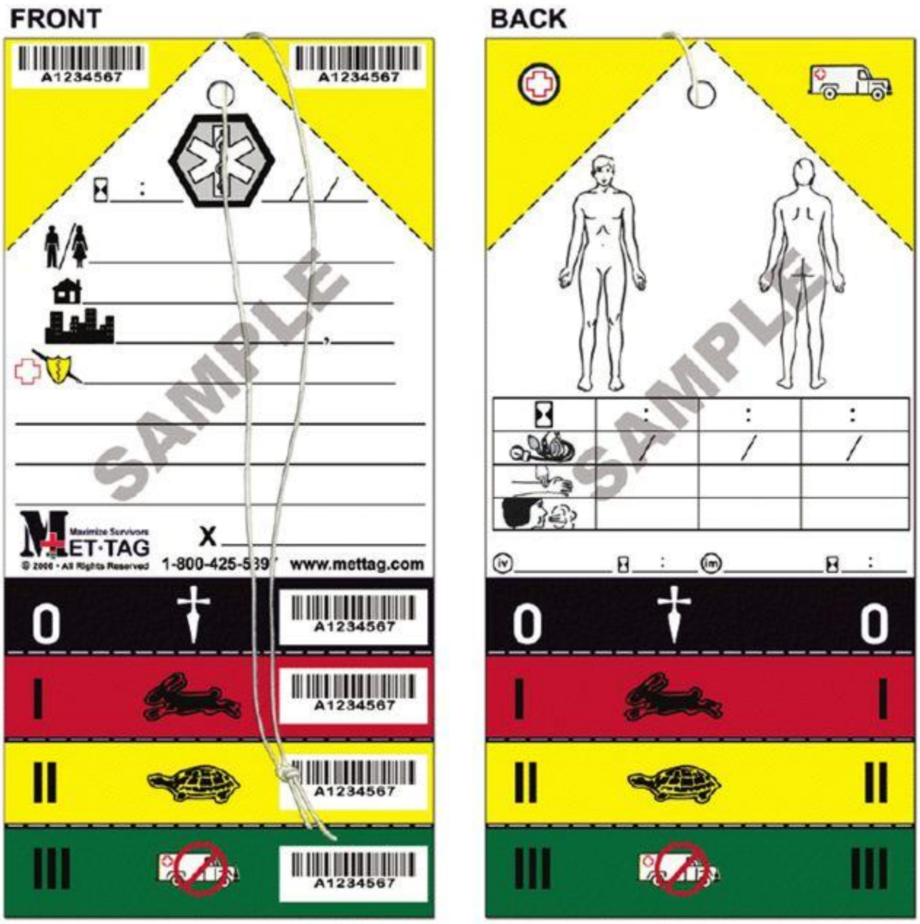


Figure 6 – Paper tags currently used during major emergency incidents. The green, yellow and red parts on the bottom of the slip can be torn off. Tearing off the green and yellow part gives the patient a higher priority, while tearing off the red part defines the patient as dead or unsavable, thus receiving the lowest priority.

In major incidents in the Oslo-area AMK sends out a Technical Manager[2], which is a doctor who manages all medical operations at the scene. In addition an Operational Commander is defined, normally the most experienced paramedics at the scene. The Technical Manager is an educated doctor, and is responsible for sustaining the life of the patients at the scene. This person normally lacks operational experience and is supplemented with the Operational Commander. Operational Commander administrates the resources at the scene, i.e. decides who does what.

As mentioned earlier when defining major incidents, the paramedics will establish a place for life-sustaining treatment when the number of patients implies that they will have to wait before they can be transported to a hospital. Since this life-sustaining

[2] Technical Manager is known in Norway as '*Fagleder Helse*'.

treatment is performed by the paramedics, resources are drawn from the ambulances. This means that fewer are available to actually transport the patients to hospitals, something that prolongs the wait for patients at the scene. This is something the interviewees think is difficult as their main purpose as paramedics is to transport patients as quickly as possible to the nearest hospital, knowing that the longer a critically wounded patient have to wait outside a hospital, the higher the risk is for loosing the patient. One simple solution to this problem could be to have police officers or fire fighters drive the ambulances in case of man shortage. It is these major incidents that this master thesis will focus on.

5.2 Collaborative training exercise in Stavanger

To improve the collaboration between the different emergency agencies (Fire, police and paramedical) multi-departmental training exercises are organized. On 14.04.11 such a training exercise was conducted in Stavanger. As representatives for SINTEF one Ph.D. candidate, one post doc and a master student (Mads Jahren) participated as observers during the training exercise. There were also many other observers to the exercise (See Figure 7). We also had the opportunity to interview key personnel after the training exercise was completed.

Figure 7 - Observers in blue wests and organizers without. Personnel in blue wests are to be ignored by the emergency personnel during training exercises.

5.2.1 The case of the training exercise

To ensure that the training exercise is as close to real accidents as possible only a few leaders knew that this training exercise would be held. Therefore when the call came to AMK everyone would have the impression that this was a real incident. The caller stated that there had been an explosion in a crane at a dock just outside of Stavanger city (See Figure 8).

Figure 8 – The crane in which the training exercise was conducted.

The person calling AMK said that there were approximately 4-5 persons inside the crane, and that there was smoke coming out of it (See Figure 9).

Figure 9 – Smoke coming out of the roof of the crane. The visibility was severely reduced.

Figure 10 – The only access route to the crane. The steps were extremely steep.

A smoke-machine was fitted inside the crane so that the emergency personnel could actually see how much smoke there was, and thereby emphasizing the extra challenge this implied. Since smoke from smoke-machines consists of a mix of steam and neutral oils it is harmless for anyone breathing in it. Three persons and one doll were placed around in the two floors inside the house of the crane. On each person/doll there was a note telling the person finding him/her what the symptoms of the patient was.

Figure 11 – The stairs inside the crane was both steep and narrow, being a challenge for fire fighters carrying oxygen tanks on their backs. Carrying patients down here proved to be difficult, and they were instead taken by the helicopter from the roof of the crane. When the smoke machine was on it became impossible to see anything, and it was therefore also impossible to photograph.

The crane itself was selected because it is not a typical mission location, and the organizers wanted everyone to experience a new challenge. It especially posed extra challenges regarding risk assessments, not only because of the smoke, but also because of the height, lack of open space and extremely steep staircases and ladders (See Figure 10 and Figure 11). Additionally the organizers wanted to train an 'alpine rescue team' who needed training in lowering patients down from high locations using stretchers and climbing gear (See Figure 12).

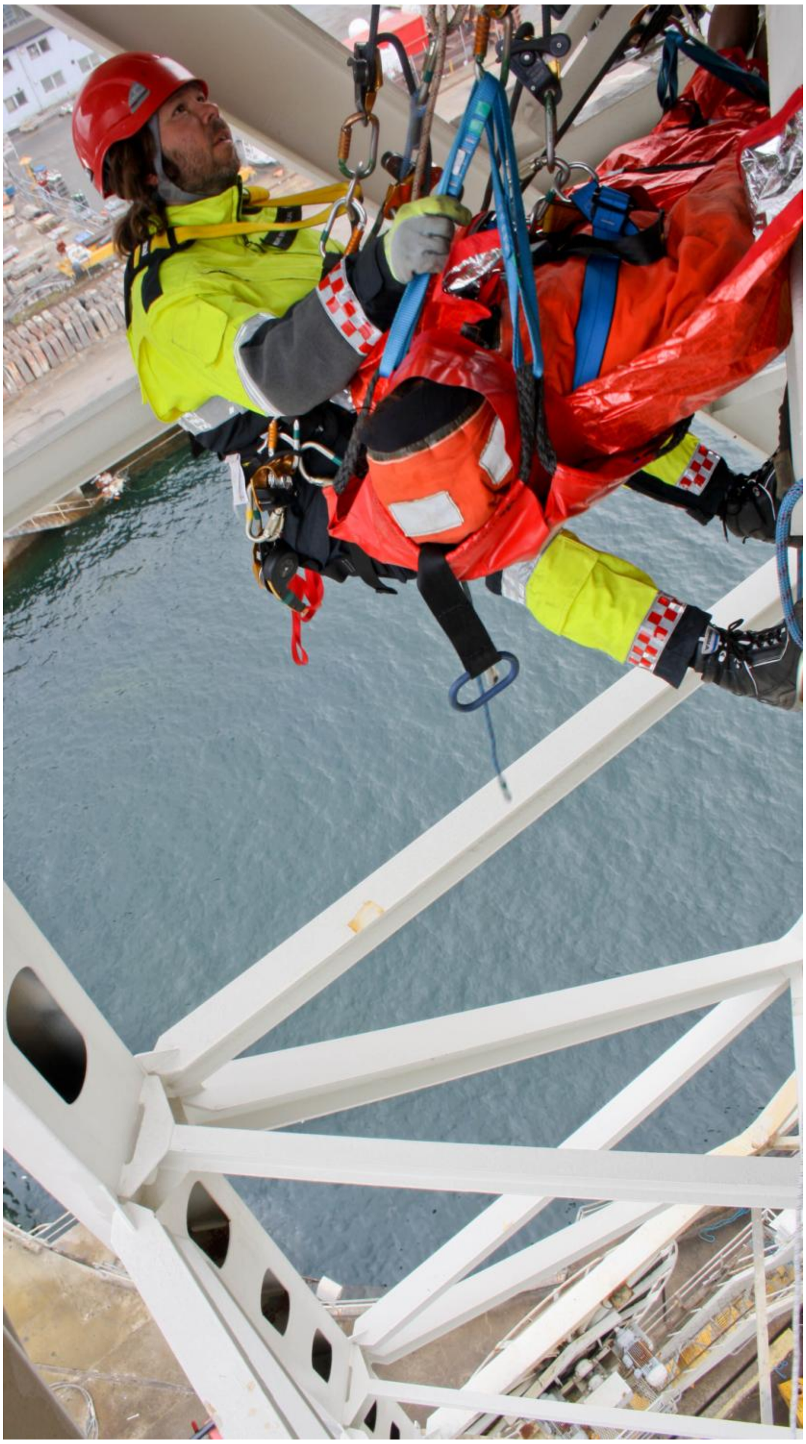


Figure 12 – The alpine rescue team lowers a patient down from the crane using climbing gear and a stretcher.

5.2.2 The course of the training exercise

The training exercise started at 10:00 a.m. An emergency call was first made to the local security personnel at the gate of the industrial area. The security personnel then again dialed the emergency number 112, which is the number of the police agency. They sent both fire trucks and ambulances in addition to police vehicles. The local industrial defense established ongoing contact with Technical Manager from the fire agency and paramedics and immediately sent three smoke divers up into the crane equipped with powder extinguishers. The rest of the security force established a perimeter and told the gate to maintain normal traffic.

5.2.3 The role of the researchers

All observers of the training exercise wore blue wests. Persons wearing these wests are recognized as observers. This is commonly known amongst emergency personnel. We as researchers were therefore totally ignored along with all other observing personnel during the course of the training exercise. Observers were located both on the ground amongst the operational commanders and local administrators, and in the crane itself. This enabled us to get a better sense of all the issues encountered in Stavanger.

After the training exercise had been completed we got the chance to interview the Operational Commanders of all agencies. These interviews were meant as a supplement to what we had observed and were of a structured nature. The interview I conducted was a group interview with two Operational Commanders from the paramedical agency. The reason for them being two, and not one which is normal, they explained was that they wanted to experiment with dividing the responsibilities between themselves. Earlier they had experienced that being only one operational commander on major incidents tended to be too much to handle for only one individual.

5.2.4 Findings from Stavanger

The fact that the operational commanders felt that being only one person in charge of the paramedics is an interesting find in itself. They reported that the amount of verbal information one has to pay attention to is too much for one person to handle. The reason for this is that all communication conducted during emergency situations is verbal, divided between two different communicational channels. One for the general incident communication, which is a multi-agency channel, and one for communication amongst paramedics. In addition they informed that they sometimes use cell phones. During the training exercise they therefore tried to listen to one channel each because, as they say: "*If you should keep on changing between the two channels you end up missing a lot*."(Translated by the researcher from Norwegian. (Interview guide for this interview is attached in Appendix 5).

They also reported having problems with the noise from the helicopter. When it hovered above the crane it got very difficult hearing what was being said, both on the radio and between personnel inside the crane. This was confirmed by the observations conducted by the researchers. Relying on a communication system which only affords verbal communication might therefore not be enough in emergency response. Based on these findings we can say that we have uncovered a potential for improvement. We observed that a lot of the communication done verbally is the communication of positions and statuses, both of personnel and of patients. Both positions and status is something that one could be able to communicate in other ways, for example through the use of visualization on mobile devices.

Another finding is that in Stavanger it is normal to refer to patients as 'critically' and 'not critically' injured patients. This is a two-leveled way of prioritizing patients that differs from the four-leveled color-based prioritaty scale used in Oslo. This confirms the inconsistency amongst different municipalities in triaging systems also experienced during 22th of July 2011 [3]. The Operational Commanders were asked about this, and they confirmed that they often use this two-leveled priority scale, even though they were familiar with the 4-leveled scale. They even thought the four-level scale was a good way to prioritize. They did however emphasize that the critically injured patients are the ones that is most important to distinct from the other patients, and said that this is why they only use two categories of patients. In other words; 'Critically' is similar to the 'red' priority color, while 'not critically' refers to the three other priority colors.

The total weight of the ambulances was another issue that was discovered. The operational commanders reported that they bring so much equipment that they "... *almost have to loose weight themselves*" ... to not exceed the legal limit. This means that when designing new equipment for paramedics one has to seriously think about how much it weighs.

Interestingly we also learned that it is very often the police or fire personnel that perform the triage at an incident site. This is because paramedics rarely enter an area which is not secure. And for an area to be secure it often has to be checked by police or fire personnel. This means that the triage-equipment has to be usable for other personnel than paramedics only. In Stavanger paramedics was not sent in before the smoke was completely gone. Until that had happened it were fire fighters who triaged and performed light treatment on the patients in the crane. On Utøya for example the paramedics had to wait for the police to secure the area before they could start their work, and some of the triaging was done by police personnel [3].

The last issue was the issue of communication inside buildings. Both operational commanders had experienced that the emergency radio often failed when the communication happened within buildings. They reported that cell phones had a much better reach inside buildings and that they often used them instead inside buildings. Creating a better communicational system for buildings, tunnels and other sites with poor signal coverage is a task that might improve emergency response.

5.3 Answering the six questions

Earlier in Chapter 3.2 we listed six questions, and it is time to answer them based on what we learned from the data collected in the contextual inquiry.

For resource management of paramedics, what is the system?

The system used today is based upon verbal communication and paper tags. When arriving at an incident site the first emergency worker starts to triage the area. Every patient is given a paper tag, which has a priority color and a unique ID. When the triage is done resources are sent to their different patients through verbal communication.

What is the environment in which emergency response occurs and what is the relation the system has with its environment?

The environment is extremely different from incident to incident. There are two flaws in the system used today in relation to the environment. One is that verbal communication is vulnerable to noise, as with the helicopter in Stavanger. Another is that the emergency radios often loose signal inside of larger buildings and tunnels.

What is the feedback provided by the system, both of statuses and errors?

There is little feedback provided by the system used today. The status and ID is only visible when one can actually see the patient with your own eyes. There is no feedback of the patients' current location, other than that provided by the triager. Furthermore there is no feedback of any changes to a patient's status or position. All feedback is communicated verbally, normally through the use of the emergency radio. Also, patients can easily steal other patients' tags to ensure better prioritization of themselves.

How does the system measure when it has achieved its goal?

The system relies completely on the triager's ability to remember where every patient is positioned and to remember if everyone has been consulted. The system has achieved its goal when the operational commander says so.

Who monitors the system?

The Operational Commander, which often is the person who performed the triage. The reason for him/her becoming the local organizer is that s/he has already acquired a situational overview and is therefore best suited to delegate personnel.

Is the system meeting the needs of its users?

The system is meeting the needs of its users, but we have uncovered large potentials for improvement. We have seen that the amount of information shared over the emergency radio both exceeds the capacity of the emergency personnel and of the communication system itself. This observation is confirmed in other incidents both in Norway and abroad [3, 15].

6 From data to design

In this chapter we will discuss findings from Chapter 5 and data presented in the background that relates to the design process. Three needs will be presented based on the researchers understanding of the problem area. These will be further discussed in Chapter 11.2, related to whether or not they were met by the system designed in this master thesis. Also a few alternatives regarding other parts of the system than the Operational Commanders interface is presented.

6.1 Defining system goals

Based on the data gathered in this master thesis three needs have been identified:

Need #1: Reducing the strain on the emergency radio

It has been discovered in this master thesis that there is a need for an improved communications system. In Stavanger it was observed that personnel had to wait for the radio to become available. This was also experienced to be a problem during the incidents of 22th of July 2011 [3], and is also observed to be a problem abroad [15]. We have also seen that the communications system utilized today has exceeded the capacity of one operational commander resulting in two OCs being used in Stavanger. Reducing the strain imposed on the emergency radio due to the large amount of verbal information sharing therefore became the first objective of the thesis.

Need #2: Reducing the vulnerability to noise

During the training exercise in Stavanger it was observed that the communication was considerably disturbed when the helicopter arrived. This was confirmed in later interviews as a communicational problem. Helicopters are often used in larger emergency operations like Utøya [3], and noise from environmental elements like for instance waterfalls and highways could often pose a challenge for verbal communication. The communications system should therefore not be as vulnerable to noise as it currently is. Reducing the vulnerability to noise therefore became the second objective of the thesis.

Need #3: Creating a new system for triaging

There are multiple weaknesses in the way triages are done today. Both that one cannot change the status of a patient to one of less priority, that patients can steal other patients tags, that patients themselves actually can change their own status, and that their position has to be verbally communicated poses considerable incentives to design a new system for triaging. We have learned from the operation at Utøya and through the interviews conducted in this master thesis that there is inconsistency between different municipalities regarding triaging systems, terminology and routines (This inconsistency was also discovered between the paramedics in Stavanger and in Oslo) [3]. Based on this it has been recommended that a new national system for triaging of patients in major incidents should be created [3].

This section will discuss these challenges and will present different hypothesis of how a new system might improve upon the practices of today.

6.2 Visualization of positions and statuses

To visualize a geographical position there are few, if any, better alternatives than using maps. Both Eide [33] and Joshi [34] used maps in their designs [33, 34]. There are few other more intuitive ways to communicate to a person where something is located. It is also found that "*Rapid access to geospatial information is crucial to decision-making in emergency situations when decision makers need to work collaboratively, using GIS for hazard mapping and visualization as well as for improving situational awareness*". [35:119] (GIS = Geospatial Information System, i.e. a map-based information system). But how to visualize something in a map is not so obvious. There is a lot of information needed when visualizing an actor in a map, whether it is a patient or an emergency worker. Let's provide a short list of what information is needed for each actor:

Emergency workers:

- What kind of worker it is. Whether it is a fire fighter, police officer or a paramedic.
- What the workers specific ID is. Every worker should be distinguishable from each other to provide opportunity for direct communication over the emergency radio to a specific worker.
- If the worker is available or not. Seeing who is engaged in tasks already, and who is available for new orders is naturally important for the operational commander.

Patients:

- What priority the patient has been given. In major incidents where there is more patients than ambulances operational commanders has to make sure that critically injured patients are tended to first. Seeing this in the map would enable the operational commander to better know where and how to organize the available resources.

- An ID. Each patient should be given, as they are given today, a specific ID. This can be automatically provided by the tag to the system. One extra advantage of having an automatic ID is that it would be completely anonymous in verbal communication. Journalist often hack into the communication between emergency personnel and having only an ID instead of names or traits when talking about a patient reduces the risk of media knowing who it is talked about. The importance of patient confidentiality is further underlined in [19]. Here they argue a need for encrypted signals. Using ID-number would however hide the patients' personal information reducing the need for encryption.

- If the patient is receiving help or not. The important part here is that operational commanders should be able to tell who is yet to be treated.

6.2.1 Using colors to visualize priority level

As informed by the paramedics from Oslo a color code is currently being used to define a patient's priority level. This color is also used in communication with the hospitals, especially when it is a code 'red', which means that the patient's life is in critical danger. It would therefore be valid to assume that a system using this color code for visualization of a patient's priority would be understandable for the users. However, it is important to think critically when making a design choice so a short discussion on the intuitiveness of the color code is appropriate.

In his master thesis Aslak Eide discusses the intuitiveness when it comes to colors and risk interpretation. He argued that there is a hierarchy of different colors ability to represent risk. Red is perceived as higher risk than yellow, and yellow of higher risk than green. There is however a difference to representing risks and representing priority. To uncover how people in general perceive priority and colors a small questionnaire was conducted (See Appendix 8 for questionnaire). The participants were shown a paper-based prototype (A screenshot of the map-based interface prototype created in Android). In it was one icon of each of the five priority colors suggested: Red, orange, green, gray and black. They were asked to imagine that they were an operative commander and that they had 5 patients with different levels of priority given. Then they were then asked to write down the order in which they would assign resources to aid the patients in the field. 12 people responded to the questionnaire. This is interpreted to be a sufficient amount of respondents since interaction designers commonly use a small number of respondents, often less than 20 [6]. The results can be seen in Figure 13:

	1	2	3	4	5		Comments
1	Red	Orange	Black	Gray	Green	3	
2	Red	Orange	Black	Gray	Green	3	
3	Red	Orange	Black	Gray	Green	3	
4	Red	Orange	Gray	Green	Black	3	
5	Red	Orange	Gray	Green	Black	3	
6	Red	Orange	Gray	Green	Black	3	*Black interpreted as dead*
7	Red	Orange	Green	Gray	Black	2	
8	Red	Orange	Green	Gray	Black	2	
9	Red	Orange	Gray	Black	Green	1	
10	Red	Orange	Green	Black/gray	Black/gray	1	*Gray/green both interpreted as dead*
11	Red	Black	Gray	Orange	Green	1	
12	Black	Red	Orange	Green	Gray	1	*Black interpreted as practically dead*

Figure 13 – The results of the color questionnaire. The participants were asked to prioritize the different colors of patients into gradiant of priority ranging from 1 (Highest) to 5 (Lowest).

Looking at what the participants responded we can argue that using a five leveled colored-based priority system provides room for misinterpretation. There is however some interesting points to deduct. First of all we notice that the hierarchy of colors mentioned above has been confirmed. All of the participants prioritized red above orange, and orange above green. Secondly 11 out of 12 respondents made red the highest priority. 10 of these 11 made orange the second priority. Based on this we can argue that choosing red as the color for top priority and orange as the second top priority would be intuitive, meaning that learnability is enhanced. This correlates with the practice of today. When it comes to a third color of priority we can see that the answers differ considerably. Only half of the respondents interpreted green as of a higher priority than black. The fifth color gray is the only color that is not used today. This one also failed to provide consistent interpretations by the respondents. This means that if one should use these colors as a way of prioritizing patients or tasks, some kind of instructions would have to be given.

6.3 Tags with sensors

When personnel - either being paramedics, police officers or fire fighters - perform a triage of an emergency scene it is currently being done completely manually. It is done using paper-notes which they tag on each patient. These paper-notes communicate the patients medical state considered by the person doing the triage, and is classified into 4 levels of priority: Red, yellow, green and black. It also communicates the patients "field ID", i.e. the patients name amongst the personnel operating on the emergency scene.

We have identified four weaknesses with this system. The first weakness is that it solely depends upon the triager's ability to decide what priority the patient should get, since it is completely analog. Using sensory data when tagging a patient might increase the accuracy of patient diagnosing. The sensory data one could imagine to be used is for instance heart-rate, body heat and level of breathing. Also SPO2-clamps, which are easily mounted on the finger of a patient, could show the levels of oxygen and other gasses that might have contaminated the patient's blood – for example carbon monoxide (CO).

Another weakness is that once the triager has given a patient a certain priority it stays the same, no matter what happens to the patient. The status is only changed when, and if, someone reassesses the situation. Additionally, with the analog system currently in use there is no way of decreasing a patient's priority. This means that if a patient is suddenly better than previously perceived by the triager there is no way to go down in priority, e.g. from red to yellow. If it has gotten worse however, the next person assessing the patient can tear of another part of the paper-slip and thereby change the level of priority, e.g. from green to yellow or from red to black. (See Chapter 5.1.5 for more details about the paper-based tag). The effect of this lack of functionality is that less injured patients could be prioritized over more severely injured individuals. When creating a system for patient-prioritization as is done in this thesis, there should be a way to change the status of a patient to whatever is considered most accurate, no matter what the previous status has been.

A third weakness of this system is that is situations where patients lie close to each other patients in great pain might actually steal other patients tags so that themselves can be prioritized higher. This is a problem which has occurred, based on verbal information provided by emergency personnel.

Fourth is the problem of communicating accurately where a patient is located. When the triager maps an area s/he relies only on verbal communication when organizing the resources available. Describing accurately where people are located is usually not a big challenge because the incident area is usually not of considerable largeness. But in some instances it is, like on Utøya 22.07-11. Here patients were scattered over a large geographical area. Accurately communicating where each of the dozens of critically injured patients were located is both a difficult and time-consuming task.

One way to enhance this tagging process could be by combining sensors with the tag. A sensor could both help the triager in his or her assessment of the patient's medical status, as well as monitor the situation when no personnel are able to help. If the patients health status changes the sensors could automatically change the priority of the patient, thereby giving the local leaders a better overview of which patients to prioritize first. Combining the medical sensors listed earlier we could get a system which tagged the patient, monitored the health status as well as positioned the patient in a map.

6.3.1 The problems of medical sensors

Although there is little doubt that medical sensors would be a great asset to this system, the sensory technology is not yet optimal for patient tagging during major emergency operations. There are a few reasons for this which has already been pointed out in Chapter 2.4.4. I will here summarize and argue more thoroughly for why these sensors will be abandoned in this master thesis. The medical sensors considered here is the sensors for heart-rate, body temperature (Which is measured through skin temperature, something that is not optimal), breathing and SPO2.

The problem of tagging patients in the field is that they are often severely injured, and very often cold – especially in the winter. When the body temperature of a patient gets below a certain level or if a certain amount of blood is lost the body starts to shut of the blood stream to all limbs. This means that if one checks for a pulse on a hypothermal patient one will not get one at all, even though the patient is alive. Already here we have a great challenge when it comes to SPO2, which is only used on fingertips. Relying on SPO2 in the field would therefore show still living patients as dead with no pulse, and can therefore not be used. However, researchers are currently trying to develop a SPO2-device that can be mounted centrally on a person's body, for example on the head (Interview guide and findings from the interview with a sensor expert can be found in Appendix 6 and Appendix 7). If they are able to create such a device it would solve this issue.

The other sensors have to be applied central on a patient's body. Skin temperature is in itself an inaccurate measure of body heat. It can be as much as up to three hours delay between body temperature and skin temperature [36]. This means that in order to get a better reading of the body temperature of a patient one has to actually get inside the body. This is a bad idea in the field. Patient might choke on sensors that are put in the mouth, and if sensors are put into other entrances to the body the patients might feel violated. It would also pose a hygienically risk to the patient since the environment is far from sterile. Penetrating a patient's body with sensor technology would in other words risk causing infections.

Breathing sensors could work in different ways. One is through a mask. The problem with a mask is that it is big, and would cause a lot of strain to the triager applying them. The tag should be small and light so that the triager is able to carry many around when performing the triage. It is therefore unrealistic to use a breathing mask when tagging a patient. Another possibility is through the use of a microphone recording the breathing sounds. In the field however it is often noisy, and this would greatly influence the quality of data received. A third option that might work in the field is through measuring the chest expanding. There is one problem with this option as well though. If sensors are to detect chest expansion there has to be at least two sensors firmly attached to a patient at different sides of the chest. This implies that the paramedics have to get beneath the clothes of a patient to apply the sensors. Heart-rate sensors also have to be mounted central to a patient's body, ideally close to a person's heart. The problem is here the same as it is for breathing sensors. Mounting the sensors beneath the clothes of a patient has two consequences. The first is that it is time-consuming and complicated to apply. In a triage the tag needs to be easy to use and quick to apply, or else they will not use it [5]. The second consequence is that it, especially during the winter, poses a serious health risk to the patients. Removing clothes to apply tags means that the patient will keep less warm and run a higher risk of hypothermia.

Heart-rate sensors could also be mounted close to the arteries in the neck. This however poses a risk for causing breathing difficulties for patients, and potentially choking risks. The tags used today are in fact attached to the patients with a string around his/her neck (See Figure 14), but in order to record the pulse of a patient one has to mount this more tightly, something that would be a greater risk to the patients health than the string used today.

Figure 14 – A tag attatched to a patient during an emergency training exercize.

Based on these thoughts it was decided that the use of medical sensors, with he technology available today, would not be appropriate and is therefore not chosen for the system designed in this thesis.

6.3.2 A suggestion for the tag

Two types of tags have been discussed in this master thesis: 1 - Medical sensor tags which records a patient's medical status, and 2 - GPS/RF-based location tags which provide data about its geographical position. These tags could of course have been combined into a single unit, but now with medical sensor tags out of the question we are left with the location tag.

The data provided by the analog paper-based tags used today is patient ID and priority level. This should also be incorporated by any new tags developed. Both ID number and priority status should be clearly visible and easy to see. Additionally we have learned that verbally communicating accurate locations of patients in the field is a difficult and time-consuming task. Using other means for communicating a patient's location is therefore desirable.

The data provided is therefore *location*, *ID* and *priority*. This should be made visible with emphasis on intuitiveness and effectiveness. We hypothesize in this thesis that visualization of such information will reduce the amount of this information being shared verbally over the emergency radio.

6.3.3 Self-powered wearable devices

Using wireless tags to register and send the patients position to the system requires power. Although the energy consumption by these tags is minimal they are useless if they run out of power. There is now two ways to make sure that these sensory devices have sufficient power. One is through the use of batteries, the other is through the use of energy harvesters [37]. An energy harvester, also called 'energy scavenger' is a centimeter-size power microplant that does not require fossil fuel, but instead converts any available surrounding energy-source into electricity, i.e. vibrations, a wind, a water flow, an electromagnetic energy or thermal energy when available. There is three ways to harvest energy when it comes to attaching an energy harvester to a patient; Either electromagnetic energy (mainly light), patient movement and/or "… the heat flow caused by the difference in temperature between human body and the ambient."[37]. It would be, as argued earlier, best to avoid mounting devices underneath the clothes of patients lying in the field. Since most patients are still it is most natural to use electromagnetic energy to harvest energy. Both energy harvesters and batteries have advantages and disadvantages (See Table 1).

	Advantages	Disadvantages
Batteries	- Reliable - Steady supply of power	- Runs out of power - Has to be recharged or replaced manually
Energy harvesters	- Recharges automatically - Does not run out of power	- Unstable supply of power - Relies on outside factors (i.e. body-temperature)

Table 1 – Batteries vs energy harvesters

If one is able to combine these technologies it would provide a reliable and lasting supply of power. The power would be drawn from the battery when the energy harvester does not have access to enough ambient power. And when the energy harvester does produce electricity it can recharge the battery and power the device at the same time. Combining the two also means that one can settle with a smaller battery than one would need otherwise, meaning that the size and weight of the device won't be drastically increased.

Because electrical tags can be used many times over power is an important challenge. With batteries the tag does not need to receive any energy when it is actually tagged to a patient. But it needs to be recharged whenever it is not used. One easy way to solve this challenge could be to use electromagnetic harvesters on the tags, and keep them in a box with light when not used.

6.4 Management of the personnel

With the sensory-based tags the Operational Commander will quickly get a visual overview of the situation. Every sensor could send its own status and position to a central database which again could generate a visual map based on for instance GoogleMaps. Red, green, yellow, blue and black patients could have different icons, as well as different icons for paramedical personnel, police personnel and fire personnel.

This would enable the Operational Commander to know how many patients there are at any time, how many that are of high priority and where they are located. If all personnel also carry sensors defining who they are at all times the Operational Commander would also know who is closest to each patient. This would enable him/her to distribute patients to the personnel in the closest vicinity. This could be done by for example clicking at a patient and then clicking on an idle emergency worker. The system would then contact the person and automatically perform the communication needed so that the worker would know where to go and who to help (Read 'Text-based communication' for elaboration on how this communication might be conducted).

It would also be possible to create a fully automated system which organizes resources according to the priority given to each patient. The system could detect when personnel are available and then give them a patient that is of the highest priority, and in the closest vicinity. Making the system automatic would enhance effectiveness as computers are quicker than humans when it comes to simple tasks like this one technically is. The problem with a fully automated system would be that there would be nobody reflecting on the prioritization. Since every situation is different it will be very difficult creating a system that always makes the right priorities.

6.4.1 Reducing the verbal communication for paramedics

From the interviews we can find that are several things that could be done better if done in a different way. By now the paramedics use either manual communication like shouting and body language, or radio at two different frequencies. This is, as we also observed in Stavanger, fragile means of communication. In Stavanger there was both the problem with lack of sight as well as high amount of noise that severely limited the communicational abilities amongst the personnel at the scene. In addition the personnel sometimes had to wait for the line to be idle before they could use it themselves. Also, when the person is able to use the radio it is a one-to-all communication. Although this is not a direct problem it clutters the information provided by this "to all" communication. This might cause personnel to pay less attention to what is being said on the radio, which again might affect the quality of communication.

These communicational challenges can greatly slow down the efficiency of the emergency workers. Although completely replacing vocal communication would be both unnecessary as well as very difficult, it is both possible and appropriate to supplement the communication amongst the personnel on the ground. This especially applies amongst local leaders and their crews.

To meet these communicational challenges one could look into text-based messages with simple-optioned answer buttons. If a paramedical worker has access to for example a smart phone he or she would be able to receive orders from their leaders without the use of the radio. This will greatly reduce the stress imposed on the radio network. Giving the paramedics simple "confirm/decline" buttons for answering to orders, and a "mission completed" button to show that they are idle and waiting for the next order would be a simple way to communicate this basic information. This also would enable multiple paramedics to report simultaneously to the Operational Commander, or any other local leader, that they are ready for the next task. If the Operational Commander has a list of tasks readily available the orders could be given automatically by the system when personnel reports in as "idle", something that might increase the efficiency of the whole operation. We hypothesize on the basis of this that visualization of information will reduce the amount of verbal communication needed.

6.4.2 An interface for the paramedics

Since the system would know the position of both the patient and the person receiving the order it would be possible to visually show what direction the patient is in and how far away he/she is. Augmented Reality (AR) is a fairly new technology that offers exiting new possibilities for emergency personnel. AR technology uses video and location awareness technology to visualize elements in a screen. The elements are placed based on the devices' awareness of where the device itself is as well as information of where the element is located. The user then sees a real time 'stream' of the area in which s/he looks at through the camera and screen of the device and is able to see the elements where they actually are, displaying both direction and distance [38]. This is why it is called 'Augmented Reality' – users are able to see the reality in an augmented, meaning a combination of changed and enhanced, way.

This technology would of course imply that the personnel need to bring some type of screen with them at all times. This is a challenge when it comes to weight and non-intrusiveness [10]. Emergency personnel are reliant on having their hands free, so any screens carried with them should be integrated into their gear, for example on the wrist or mounted on the head as a part of for example a helmet [10]. Screens mounted to the head would however imply a considerable extra cost, and is therefore less likely to be implemented amongst every single emergency field worker.

There are already many applications that could provide a visualization of the patient and the paramedic in a map. They also provide different ways of displaying how to get to the patient, both by car and by foot. Out of a variety of Android map-applications the free 'GPS Compass App' was chosen to demonstrate how direction could be shown to paramedics. This application shows the phones location in a map and provides functionality for showing waypoints to for example a patient. It shows a dashed line between the phone and the patient. The reason for this app being chosen over for example 'Modern Compass' is that the map rotates according to the compass direction it is held. This should make it more intuitively understandable than a static map with a rotating compass in the corner. (See Figure 15)

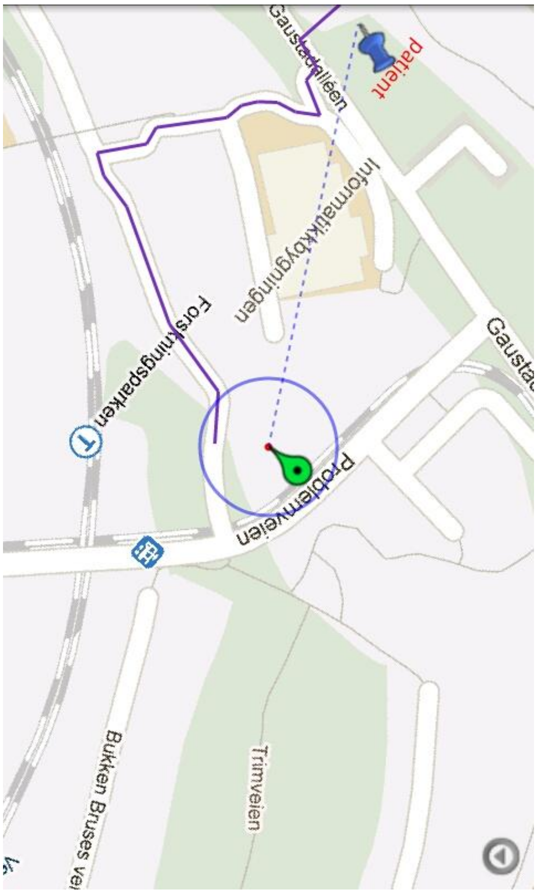


Figure 15 - Screenshot of the GPS Compass App with directions to a patient-waypoint. The map rotates as the device is rotated using compass technology.

The interface was discussed with work domain experts, being an Operational Commander and a paramedical trainee (See Chapter 9). The feedback from this discussion showed that this could be an alternative to how this information could be visualized and was considered to be appropriate by both the OC and the trainee.

Additionally the Operational commander was asked for any other information that should be displayed in this app, e.g. the patient's priority status and the distance to the patient. Functionality that allows paramedics to report either 'Task Completed' or 'Available for new orders' should be present. This can be either incorporated into a touch screen or, perhaps even more appropriate, as hardware buttons that allow users to interact with the system even when wearing gloves or when visibility is poor [10]; - Hardware buttons allows users to feel where buttons are located and can therefore be able to operate the system without having to use their eyes.

Further discussions on interfaces for 'field workers' can be found in [10]. Here they emphasize non-intrusiveness, mobility and automatic sensor reporting.

7 First prototype

In this chapter the first of four prototypes is presented. Each of the other prototypes is presented in Chapters 8, 9 and 10. It is designed based on the data gathered and is suggested as a mean to reduce the verbal communication conducted over the emergency radio while also giving the user(s) a real-time situational overview of the incident area and the number of resources in it. A brainstorming session with experts within technical, graphical and interaction design was conducted to evaluate it and provide further suggestions both for the management system, for the interface and concrete suggestions of icon designs.

7.1 The brainstorming session

The icon brainstorming session had two main goals. The first goal was to get feedback on the management system and the user interface developed. The second, and main goal, was to design some specific suggestions for icons, using the prototype as a boundary object to ensure a common system image amongst the participants and the designer [23]. The participants were 2 master students from the program 'Informatics: Design, use and interaction' and one master student within IT management. A fourth participant was a computer programmer from the program 'Informatics: Programming and networks'. All of these participants could be considered experts within their field.

The importance of intuitive and learnable icons has been discussed earlier in Chapter 4.2. We have learned that paramedics use a color-scale to refer to a patient or missions priority. Since this color-scale is already adapted by the paramedical community we should incorporate this in the icons as well. Therefore the participants of the icon brainstorming session were given instructions to design icons for patients that could be shown with different colors. In addition to the colors used by paramedics today a fifth color was suggested by the researcher. The suggested color blue should represent patients that have been checked by paramedics and regarded as 'dead' or 'unsavable'. Since only doctors can declare someone dead this feedback was suggested as a way to ensure that also the doctor can know who he or she has checked and who is yet to be checked. In addition to focusing on the icon design they were encouraged to provide feedback on the system as a whole and on the interface they were presented (See Figure 16).

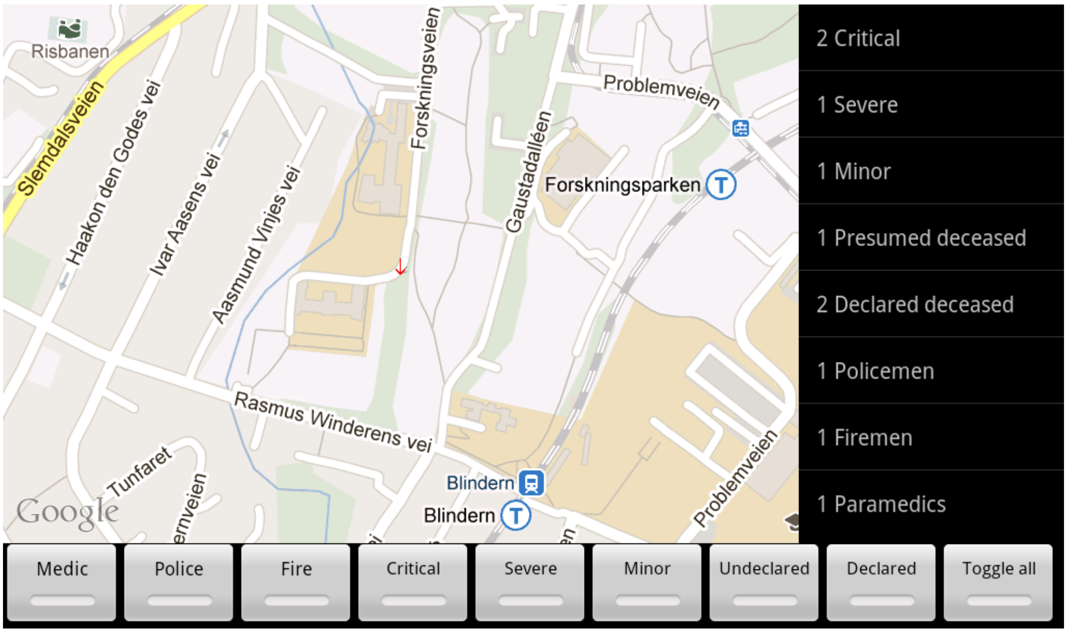


Figure 16 – Screenshot of the first prototype interface. The buttons at the bottom of the screen are toggle-buttons that shows/hides icons in the defined group. The list on the right side of the screen is an example of textual overview of resources and patients in the area.

7.1.1 The instructions given to the participants

There were two groups of icons that the participants were asked to discuss and collaboratively design. The two groups were 'icons for patients in the field' and 'icons for resources in the field'. In the first phase of the session they were asked to not criticize any ideas or discuss them in detail but to rather develop as many ideas as possible, however crazy they might be. This part of the session gave a multitude of possible icon designs and many suggestions for the interface.

Patient icons should be able to have the any of the five colors without changing shape. This is to ensure consistency in and learnability of the system. Additionally should the patient icons show the unique ID of the tag, and thereby the patients ID. This is to ensure that it is easy to verbally refer to a specific patient. The last criterion for patient icons is that they should be able to show the operational commander whether or not they have been appointed a resource or not. It should change enough for everyone to see this, but still retain enough of its specifics to show everyone what kind of priority the patient has and the ID of the patient.

Resource icons should be distinctable from patient icons. There should be three different 'values' – police, fire and paramedical resource. It should be clear by the design of the icon what kind of resource the icon represent. These three should however be similar enough to intuitively communicate that they all represent resources. As for the patient icons the icons should show the resource unique ID, and should show whether the resource is busy or ready to be assigned.

7.2 Findings from the brainstorming session

The participants of the brainstorming session evaluated the interface proposed by the prototype both through interaction with the interface on a Galaxy Tab GT-P1000 and through discussion with the researcher and with each other. The prototype was digital and of high-fidelity. They had many comments, some of which are discussed here.

7.2.1 Positive feedback

Use color codes - confirming this as a good idea.

All of the participants agreed that the use of different colors to communicate the degree of priority was both intuitive and optimal. They also thought the four colors of today were ideal for the purpose assigned to them. They did not however think that the color blue should represent patients that have not yet been declared by a doctor as dead. This is because they immediately connect this color with the police, thus causing confusion. They instead suggested the color gray for this purpose.

One additional point they made when discussing the issue of colors was the problem with color-blind users. If the users might be color blind the icons has to be designed so that also they can tell different levels of priority apart. This is however not considered when designing icons based on the brainstorming session in this thesis based on an assumption that emergency personnel has to be able to distinct different colors from each other.

The use of a map-based interface

The participants discussed ways of creating an interface that would quickly and as optimal as possible provide an overview of a situation, as well as enabling resource allocation and re-allocation. They all agreed that an interface based on a map of the incident area, as was suggested through the prototype.

Furthermore they confirmed the need for a supplementing list that would enable the operational commander to get a statistical overview of the situation; how many are critically injured, and how many paramedics are operating in the area for example. This is already incorporated in the prototype design. What they missed however was an overview of available resources and unattended patients. This should be incorporated in the next prototype design.

The specifics of the icons

Having each icon display a unique ID was viewed as a key feature to ensure better orientation communication. Additionally they saw the positive side effect of being able to increase patient anonymity in the communication in relation to for example media, who are known to tap into the communication of emergency agencies.

They did have a short argument about the need for displaying the ID at all times. It was suggested that one could hide the ID from the general icons, and only show it when the user tapped on an icon. But after a short argument they agreed that being able to verbally assigning larger groups of personnel to larger groups of patients would be difficult if the user would have to tap into each icon before the ID of both patients and personnel is revealed.

7.2.2 Constructive feedback

Creating zones or layers

It was for major incidents suggested that the Operational Commander should be able to divide an area into different zones through interactions with the interface. Dividing an area into different zones is a good idea for communicating where personnel should go or for dividing are responsibilities. In this thesis however we argue that the system designed in this master thesis should enable an incident to be organized by fewer leaders and that real time visualization of the incident area will allow the Operational Commander to better retain a situational overview than the system used today. The communication of where personnel should go will also be handled through visualization in a real time and will therefore not rely on the use of zones. Based on this we have regarded this functionality as secondary and instead prioritized the development of other utilities.

However, when considering buildings the use of zones was again brought up. The participants suggested that to distinguish each floor from the others one could make the system create a unique zone for each floor. The zones here could possibly be called floors or layers to make it even more understandable for new users. The interface would then have to provide functionality for selecting what layer one wish to view, as well as functionality to watch them all, if one wants a higher level of overview.

Patient and resource icons

It is vital that the patient icons are distinguishable from the resource icons. This has been achieved by designing the icons both different when it comes to shape as well as coloring. All patient icons have a circular top, are filled with a color and have a white ID number. All resource icons on the other hand has a flat top, white, has ID's with letters and numbers and has agency-specific symbols (See Figure 17).

Figure 17 - The basic icons

Aggregating icons

In many cases more than one icon will be displayed close to one another. Patients are often located near each other. Therefore, depending on the zoom level in the interface, the icons will risk overlapping each other resulting with the operational commander misinterpreting multiple patients for just one or two.

Two design solutions that would counter this problem were suggested: - Odd shaped icons, and cluster icons. Here we should note that these solutions require a more highly developed algorithm for placing icons in the interface. The algorithm used in the prototype developed in this master thesis only assigns a given icon to a given coordinate. The algorithm needed to make odd shaped icons and cluster icons work would have to be able to determine how many icons there are in a given location at a given zoom level and would have to be able to alter the icons automatically as the user zooms in or out in the map. Due to the limited time frame of this thesis work developing this algorithm was not feasible. Cluster icons will be discussed after the odd shaped icons.

Odd shaped icons

The reason for odd shaped icons being a solution to this problem is that these icons can be rotated to make room for other odd shaped icons. If for example two icons are pointing to a specific area one icon could rotate to the left and the other one to the right. By doing this one would be able to have more icons in a smaller area than if just utilizing round icons (See Figure 18).

Figure 18 - Odd shaped icons

Because the icons are designed at pixel-level numbers and letters do not respond well to being rotated. The solution for this for patient icons is that the number stays horizontal even when the icon turns. For resource icons however there is not enough space available in the icon itself to allow the ID to stay horizontal. Another solution is therefore suggested; creating an icon where the pointer turns, but where the body of the icon stays horizontal (See Figure 19).

Figure 19 - Resource icons turned

Cluster icons

In cases where there are too many icons in an area where not even odd shaped rotatable icons would be able to not overlap each other it was suggested that one could use cluster icons. These icons could display multiple patients overlapping each other at the current zoom level by creating icons that display the number of patients in the area overlapping each other. If the user zooms in on the cluster it should break up into smaller elements when the icons don't overlap each other anymore. This is referred to as decluttering of interfaces through the use of aggregation algorithms. Research on the development of such algorithms can be found at [39]. The clustering of icons is similar to what Aslak Eide did in his master thesis. By clustering buildings he was able to reduce the cognitive load imposed on the users viewing the interface [33].

The participants suggested a white circle with the number in the center of the circle. To distinct it from the other icons that display an ID it was suggested that the number had an 'x' as a prefix. Additionally they argued that the operational commander would be most interested in the number of patients with the highest priority in the cluster should be displayed. If there are a number of critically injured patients in the cluster the number should be displayed in a red arrow pointing at the white circle. If there are no critically injured the arrow should turn into the color of the patient group with the highest priority level; yellow, green, gray or black (See Figure 20).

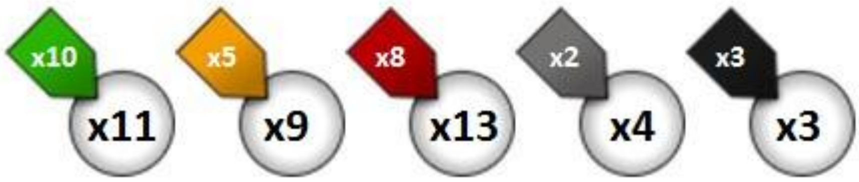


Figure 20 - Cluster icons

Also, when clicking on a cluster one should get a textual overview of all the patients incorporated in the cluster. The patients ID and status should be visible in that box.

Icon alteration

Whenever a resource is given a task, or when a patient has been assigned a resource it is important that the user will get feedback about this. If the feedback is absent from the system the user is likely to think that the previous action was not successful as described earlier in Chapter 4.2.2. The change suggested was that the icons should change the thickness of its border, thus giving feedback that it is '*weighted*' (See Figure 21).

Figure 21 – Unmarked and marked icons

Awareness of errors

There should be feedback available for the users whether or not tags are working or not. This is also suggested in [10]. If a tag should for example run out of battery or should stop sending signals due to any other reason the system have to be able to pick this up and display it for the user. The icon in the interface should not just vanish due to lack of signal. It was suggested that the icon could be grayed out or that an exclamation mark could start to blink on top of the failing tag in the interface.

A suggested interface for paramedics

It could be an idea to use Augmented Reality (AR) for the paramedics. This could mean that they could scan the landscape they are in and see what direction they should head. AR would enable the personnel to see where patients are located in any given direction even in conditions with limited visibility due to for example smoke, darkness or obstacles. Directions could be visualized in the interface, and the user would not have to actively look at a screen because the information would be available when looking at the environment. Information on patients like ID and priority levels could also be visualized. The technology of AR however is complicated, and it would be highly expensive to equip all emergency personnel with the technology needed to make such a system non-intrusive. Examples of such technology are head-up displays on goggles or visors, as mentioned in [10]. It could be interesting however to research further into the possibilities of this technology in emergency situations and related to the system designed in this master thesis.

As revealed in the interview with the paramedics in Oslo the problem of too few drivers was brought up. When both paramedics has to go out to attend to critically injured patients in the field there is nobody left to drive the ambulance. A solution here could be to have a fire-, or police officer driving.

When looking at their interface the emergency personnel should not only see their own position and the position of the patient they have been given – if any. They should also be able to see every other patient positioned in the area. Having subtle icons of all the patients and personnel in the field provided to the user could prove to be valuable orientation information. Personnel without any specific orders should be able to get an overview of the incident area enabling them to better determine who they should attend to next.

7.2.3 For the personnel doing a triage:

One of the most important parts of this new system is the solution for the triager. If the person doing the triage feels that the system is too difficult or complicated to use s/he will probably decide not to use it at all. Designing a good solution for the triager should therefore be emphasized.

The tag

The tag needs to have the id-number clearly visible. This is because when paramedics are assigned one patients amongst many at the same location they need to easily determine which one of the patients they should attend to. The ID could either be a fixed value that is displayed through for example a sticker on the tag. The drawback of this however is that each tag in the whole country would need a unique ID, meaning that the ID would have to be long. Having functionality for giving the tag an ID in each specific incident has, in addition to the upside of shorter ID's, the opportunity of numbering patients. This means that the first patient triaged will get the number '01', the second will get the number '02' and so on. This is positive because it both shows who has waited the longest since the triager tagged them, and because it displays information on the number of patients in the map. Although this information is already shown in the list to the right of the screen it could help the operational commander understand the situations quicker.

A tag-dispenser

As mentioned earlier, patients have actually stolen other patients' tags to get a higher priority themselves. To prevent this, the tag should not display the level of priority directly on the tag itself. Instead it was suggested that the priority could only be viewed with instruments that the paramedics wear, for example a scanner with a screen.

Having a tag without an interface has two consequences: First of all it gets smaller and lighter as hardware functionality is removed. Secondly it means that the interface has to be elsewhere. This brings us to the idea of creating a ’tag-dispenser’. The dispenser could have many tags in a kind of ’magazine’ that would be fed out one by one by pushing a button. In the process of feeding the tag out it could be scanned, activated, given an ID and a priority level. When triaging a multi-layer area, like buildings with multiple floors, tunnel networks etc., the triager has to be able to easily set what layer each patient is located at. This means that the dispenser would need to have the following functionality provided through an interface:

1. Setting the priority level (Green, yellow, red or gray. Black would only need to be available through the interface of the doctors’ dispenser/scanner.)

2. Setting the layer level. 0 would represent ground level, and negative values would represent below ground, while positive values above ground layers.

3. A button for feeding a chip out. The dispenser could automatically do the rest of the activation processes.

It was agreed upon that everything that happens automatically would be for the better. But setting layer-levels automatically is something that is difficult to implement. We can for example imagine algorithms calculating which layer each tag is located on at any given time through the interpretation of for example altitude. But this would not suffice because many buildings have different heights between floors. In some buildings they even have what one can call 'half-floors' betweens sections of the building. Additionally one has the challenge of elevation outside which is completely random. Having the triager set the levels seems to be the easiest solution to this challenge.

If, however, this would be considered an unsatisfactory way of triaging there can be a different solution: The chip could register its own elevation. When paramedics are given a patient they could compare their own elevation to the one provided by the chip and thereby locating the correct floor and patient. On the other hand this would mean more interaction with the system for the paramedic, who would have to look at the interface continuously until the patient was found.

8 Second prototype

In this chapter we will discuss the second prototype which was developed on the basis of the feedback gathered from the brainstorming session. This interface was tested through open-ended interviews by peers. (See Figure 22)

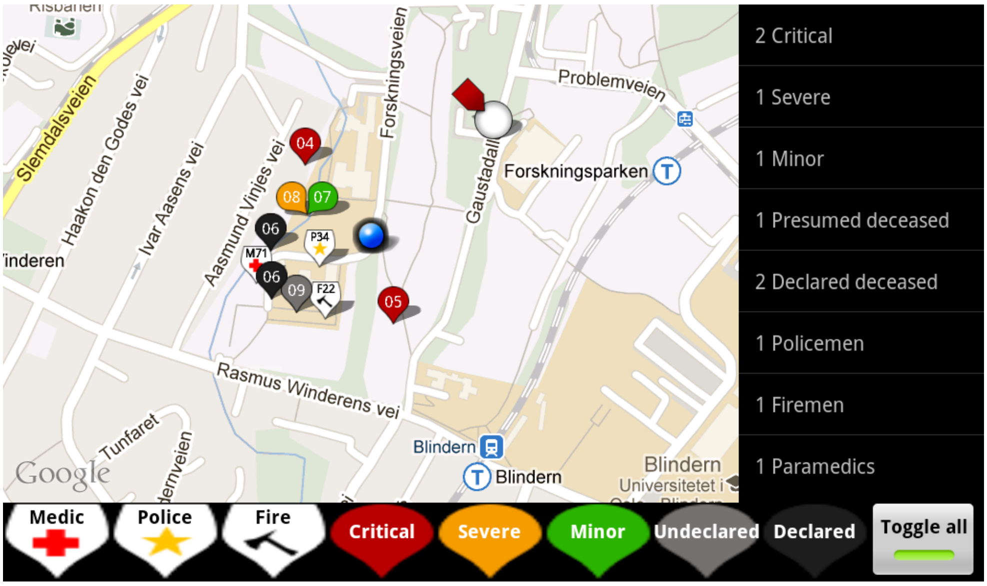


Figure 22 – Screenshot of the second prototype. Icons and buttons designs have been altered

8.1 Feedback on the newer icon design

With new icons input was needed on how intuitive they communicated their status. Four students from the master program 'Informatics: Design, use and interaction' were asked to comment on the design. They were asked the following questions:

1. *What do you think the icons represent?*
2. *What do you think the numbers on the colored icons represent?*
3. *What do you think the larger icon means? (Here I pointed to the cluster icon)*
4. *What do you think the number means in this icon?*

The results from the questioning were positive. All of the students immediately understood what the resource icons represented; e.g. fire fighter, police officer and paramedic. This they understood even though they had no prior knowledge of what the interface was for. The other icons were understood once it had been communicated to them that the user interface was for organizing resources in the field, designed for the operational commander of the paramedics.

8.2 Feedback on the interface design

In addition to conducting the brainstorming session I decided to ask friends and relatives for feedback on the interface in what is called *opportunistic evaluations (See Chapter 3.6)*. They were shown the prototype interface on the Galaxy Tab GT-P1000 device with the new icons, and asked if they understood what it was for. The users was thereafter guided through the system and asked to comment on what they thought could be done better. A short list of improvements was suggested (See Table 2).

#	Type	Comment	Design implication
1	*Interface*	The icons were easily distinctable except for the gray icon. It was not clear what this icon was for and it seemed to confuse some of the respondents.	The gray icons are kept until an end-user is asked about the validity of this category. If it is later found to be obsolete it should be removed.
2	*Interface*	The list was a bit confusing, and it was suggested that it should be moved to the bottom of the interface, so that the information would better correspond with the buttons.	The list was removed and the number of units were embedded into the buttons thus grouping related information together.
3	*Interface*	When a resource was given a patient it should be shown in the interface which patient s/he was heading for. This could be done by creating thin lines between the resource and the patient icons.	The need for this information should be further investigated with the end-users to determine if this information is needed. It is important to minimize the amount of information so that it does not exceed the cognitive capacity of the users.
4	*Interface*	The 'Location'-icon that illustrate your current position was a bit confusing because it looked somewhat similar to the 'patient'-icons. Making this icon smaller should enable the users to easier distinct it from the other icons, as well as regard it as less important. They should however be able to easily see it.	The icon was made smaller and the shade around it reduced.

Table 2 – Interface improvements suggested by opportunistic evaluations

9 Third prototype

In this chapter the third prototype is presented, and this is the last one which was evaluated before the end of this master project. It is based on the feedback received on the first two prototypes. This interface distincts itself from the previous one in four respects, which is listed in Table 3. (See also Figure 23).

#	Type	Design changes
1	*Icon design*	The icons are now more distinctable. They provide more information and seem to be more intuitive than the previous ones. The information now provided is: *priority level*, *id* and *unit type*. The new icons are odd shaped making it possible for them to rotate so that they do not cover eachother. A cluster icon is also created for areas where multiple patients are gathered in a small area on the screen, ensuring that no information is lost to the operator.
2	*Button design*	The buttons now have the same traits as the icons in the map. This makes it easier to understand that the button is related to the icons, and makes the interface more predictable. The buttons have names referring to their subjects; e.g. *'MEDIC'* for paramedic and *'CRITICAL'* for patients that are in a critical state. The length of the words 'UNDECLEARED' and 'DECLEARED' were too long to write in full, and has therefore been shortened to *'UNDECL.'* And *'DECL.'*
3	*Grouping of information*	The information on how many units there are of any kind is moved into the buttons. Since the buttons have names that explains their function, no more text is needed. This frees more space for the map. Having the number of each unit inside the button of that unit will group the information together, making it more understandable.
4	*Added feature*	A *layer-selector* has been added to the left of the interface so that specific layers can be viewable apart from other layers. This was pointed out in the brainstorming session as a great way of dealing with the challenge of for example multiple floors and above/inside tunnels.

Table 3 – Improvements implemented in the third prototype interface.

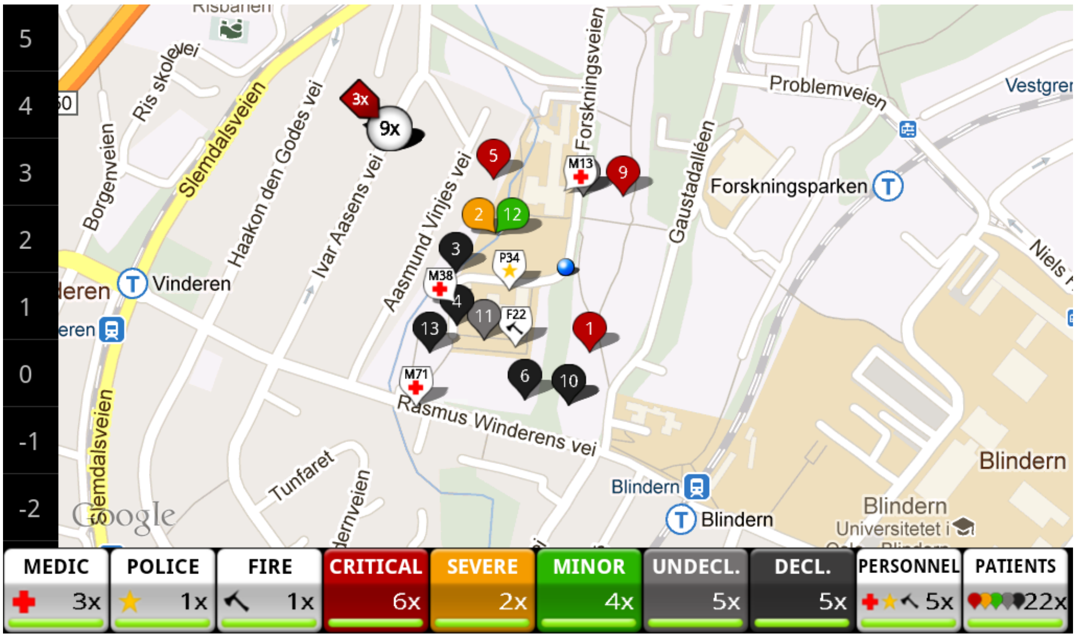


Figure 23 – Screenshot of the third prototype interface. Buttons have been redesigned, and the list has been merged into them. A layer-selector has been implemented.

9.1 Interviewing an Operational Commander

The triage system presented in this thesis was and the prototype presented above was tested on an Operational Commander (OC) working in the Oslo region. The test was conducted in an semi-structured interview with a cognitive walkthrough, or rather *jogthrough* [24], of all the elements of the system. The limited time available with the users made it necessary to choose jogthrough instead of walkthrough since this is a faster method that can test the same aspects as a more thorough walkthrough [24]. A paramedical trainee also participated in the interview. Both of these participants are regarded as *work-domain experts* [30], although one is far more experienced than the other. The interview was conducted in Oslo 17.04.12.

Three things were presented to the OC:

- The idea of the triage system as a whole, with electronic tags, automatic positioning system, visualization of personnel and patients in a map and the use of mobile devices. They were presented with the issues discovered around today’s verbal communication and its limitations as the motivation for designing this system.

- The prototype interface for the OC was presented (See Figure 23). Here feedback on icons, buttons and layer-selector was encouraged.

- The GpsCompass App was presented as a possible type of interface for personnel given an order. In this app, as we have seen earlier, there is a dashed line between the patient and the paramedic, and similar ways of visualizing this could be interesting for both interfaces - The interfaces for the OC and for the paramedics in the field.

9.1.1 Feedback on the system and prototype

Positive aspects of the system and interface

The OC, as well as the trainee had many comments about both the system and the interface. They confirmed that the verbal communicating which paramedics rely on today is unsatisfactory and that information could flow better. They agreed that it is problematic with the one-to-all communication and that it is vulnerable to noise. They responded well to the suggestion of visualizing information to reduce the strain on the emergency radio and said that "*There is no doubt that this would reduce the strain on the radio*" (The OC (Quoted and translated by the researcher)). Furthermore the OC said when looking at the prototype that "*It seems to be easier to see information and think about what to do than hearing information and trying to think*." (The OC (Quoted and translated by the researcher)).

They agreed that the system was easy to understand, i.e. that it had satisfactory learnability, and that it would save time in major incidents, i.e. that it had satisfactory efficiency. In fact the efficiency can be said to be more than satisfactory considering that it could actually enhance the efficiency of the whole emergency operation. When asked if it was ok to write that the system would be better than the one they use today the reply instantly was this: "*This system would be far better than the one used today*" (The OC (Quoted and translated by the researcher)). They elaborated that the system in addition to enhancing efficiency, would give a very pleasing and accurate real-time overview of the situation, something which is missed today. The OC was quick to point out the problem of floors in buildings and was intrigued to see that the layer functionality was provided in the prototype.

The interviewees experienced the interface as being pleasing and accurate in addition to being easily understandable. The icons and button designed in the prototype were all interpreted correctly and the responses from the interviewees were highly satisfactory. The cluster icon was the only icon needing any explanation, and when explained they thought it to be a good icon for clustering information. They responded well to the *'arrow'* pointing to the *'cluster'* in the icon showing how many there are of any kind of patient in that cluster.

Constructive comments

In addition to the positive comments described above the interviewees also suggested some changes to both the system and to the interface. The comments are listed shortly in (See Table 4) with a description of the implication this would have on the design. The comments will now be elaborated more thoroughly.

#	Type	Comment	Design implication
1	*Interface*	There is no need for the 'UNDECLEARED' category. When talking about these patients the OC used the term 'MORTES'.	The category 'UNDECLEARED' has been removed and the 'DECLEARED' category renamed to 'MORTES'
2	*System*	The electronic tag should always display the patients status so that personnel can see who has the highest priority without having to interact with a device.	The tag should be designed with a light or an other changeable color-visualiser. This should however not be changeable by the patient.
3	*System*	Patients are known to steal other patients tags to ensure higher priority for themselves.	The tag should be designed in a way that enables it to be attached to a patient so that others cannot steal it.
4	*Interface*	Sending short text-messages to personnel through the interface of the prototype was suggested.	An extra button should be added with this functionality available.
5	*System*	Blueprints of buildings would enhance the quality of personnel management in incidents involving buildings.	Further research should be conducted to investigate what is possible both leagal and practical.
6	*Interface*	Seeing which patient is receiving help and which is not (as is visualized through the use of weighted icons) is not needed. Personnel should however display if they are available for orders or not.	The weighted patient icons should be disabled, but the weighted personnel icons should be kept. Further research on how to visualize un-/available personnel is recommended.
7	*System*	The system should be scalable so that it can be used on a daily basis. This can be done by creating a system which provides functionality for reporting mission and patient status through pre-defined text messages and through the use of tags on every patient.	Further research on pre-defined messages for mission and patient status reporting is suggested.

Table 4 – Suggested improvements of management system and of the third prototype

There is no need for the dividing of 'UNDECLEARED' and DECLEARED' patients amongst paramedical personnel. The gray color only confused the interviewees and the OC said that it should be removed. He said that such information would be interesting only to the police for reporting purposes, and that he as the OC would have to trust his personnel to decide who one can save and who is unsavable or already dead. The OC referred to such patients as 'mortes', which will be the suggested name on the black button when the gray is removed.

The need for seeing which patient is currently being cared for by personnel is not something that the OC sees as needed. Major incidents are chaotic events and even though personnel are on their way to a patient they can for example be distracted by something or someone else. Patients should therefore be as visible at all times. Personnel given an order on the other hand could be useful information, or rather personnel without orders. It is therefore suggested to keep the weighted resource icons to visualize un-/available personnel and stop using the weighted patient icons.

The electronic tag should always visualize its priority. This is because the paramedics are often told to 'tend to all red patients in that area'. They should not be reliant on a handheld electronic device to see who is red and who is not. This raises the problem of patients stealing each others tags, a problem which was confirmed by the OC in this interview. He suggested that the tag should be attached to a patient so that it cannot be taken off without being broken. Research on how these tags should be designed is therefore needed. They need to be attachable to all kinds of patients without posing any health risk like strangling.

Functionality for sending a text message to a person through the interface of the prototype could be an advantage. Even though it would not be used as a main communicative channel it could be a great way of communicating to for example personnel that are in areas where the network signal is unstable like inside buildings and tunnels. In contrast to radio communication messages can be queued until the person is able to receive the message. Shorter instructions could also be communicated more effectively with messages than by radio if one has to wait for the radio to be available because someone else is using it. Text messages is currently supported by the new emergency radio system, and the system described in this thesis could utilize this system for message distribution [3].

Maps of as many buildings as possible should be available through the system so that the OC can get an as good as possible overview of the situation. Knowing where staircases are located as well as the layout of rooms and building section would help the Operational Commander better plan how to organize the emergency operation. Research on how this could be done emphasizing what is possible legally and practically is recommended.

The OC also said that it is imminent for a system to be used daily because it is so important with routines when operating in stressful environments such as major incidents. If it is not part of the daily routine, it is unlikely to be used also during major incidents. But he pointed out that it would not be a bad idea to use this system on a daily basis with regards to the minimizing of verbal communication which often clutters the emergency radios. He suggested that on daily missions, where there is a single patient, reporting could be done through a system like the one described here with a selection of pre-defined messages. This type of reporting is today done through the use of radio and is a considerable strain to its capacity. Predefined messages could also be used in reporting during major incidents whether it is a request for extra personnel, a helicopter transport unit or other requests.

Patients could also be tagged with the electronic tag suggested in this master thesis to communicate status, ID and position. This information could be useful for hospitals giving them a real-time overview of the patient situation in the region, enabling them to better prepare for the situation at hand – whether it is smaller or larger than expected.

Furthermore he pointed out that they sometimes have to evacuate large buildings due to fires. In these cases he sees a need for the electronic tag-system. Tagging all of the evacuated persons could give a quick number of how many were evacuated and could show quickly how many are receiving medical attention. This is because the medical attention is most often given in a defined area away from the other persons evacuated. Creating an algorithm which automatically calculates these numbers should be possible.

10 Final prototype

In this chapter the last prototype developed during this master project is presented. After three iterations with testing, the prototype now has a design which created positive reactions from the user group (See Chapter 9). The design has been found to be interpreted as effective, efficient, have good utility and good learnability. In this chapter the final prototype designed in this master thesis will be presented. However, further development is needed if this system is to be put into use. This will be discussed in Chapter 13.

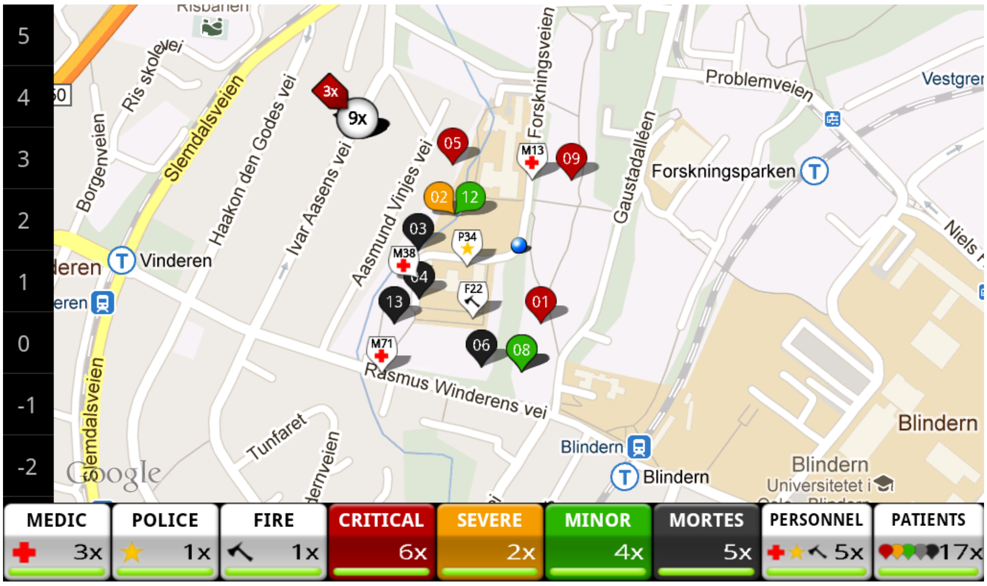


Figure 24 – Screenshot of the final prototype interface. The 'gray'-category has been removed.

The main view

This is the view that is set as default (See Figure 24). Every patient and personnel is viewable in the interface, and they will move around in the interface just as they move around in the world. The layer-selector is untoggled so that every layer is viewable in the map. Whether the layer-selector should be visible at all times or just when there are multiple layers used at the incident site is something that could be further tested. By removing it one risks reducing the memorability of the system because of the reduced consistency - It might look different the next time one uses it [4, 6]. However removing it would also reduce the number of elements on the screen constraining the users' possible actions to a minimum thus enhancing efficiency and learnability [4, 6, 14]. I chose to keep the layer-selector visible partly due to the issue of consistency, partly because of the affordance effect – only if the users see that it is there they are able to perceive it as available functionality, even when not used [6]. It should however only display the layers currently in use, with only one visible if no other layers are utilized.

When selecting a layer it is important that the users receive feedback on their action. They need to see that they have selected a layer and what layer that is. Using the 'listView'-class in Android this feedback is provided in the prototype. Selecting a layer-level now looks like this: (See Figure 25)

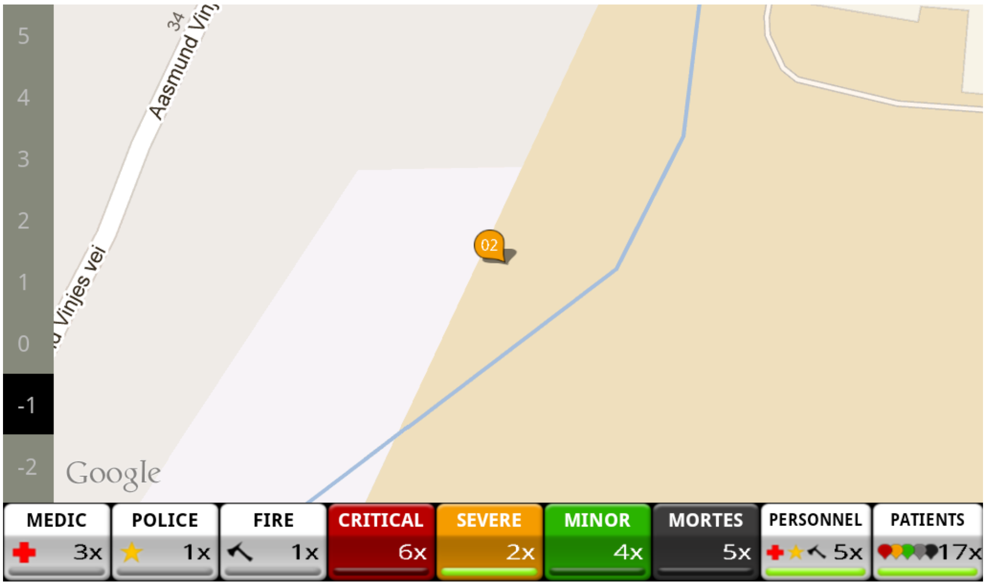


Figure 25 – An example of a selected layer. The interface here shows only 'SEVERE' patients in layer '-1'.

Toggling on/off personnel and patients

In areas where there are many patients and a lot of personnel as both was the case in the Åsta-accident [2] and on Utøya [3], functionality is needed so that the Operational Commander can view only that information which s/he finds useful at that moment. Therefore the functionality of toggling groups of icons in the interface on/off is provided. Each of the first seven buttons from the left toggles their respectable icons on/off, while the '*PERSONNEL*'-button toggles the '*MEDIC*'-, '*POLICE*'-, and '*FIRE*'-buttons on/off. The '*PATIENTS*'-button toggle the '*CRITICAL*'-, '*SEVERE*'- '*MINOR*'- and '*MORTES*'-button on/off (See Figure 26 and Figure 27).

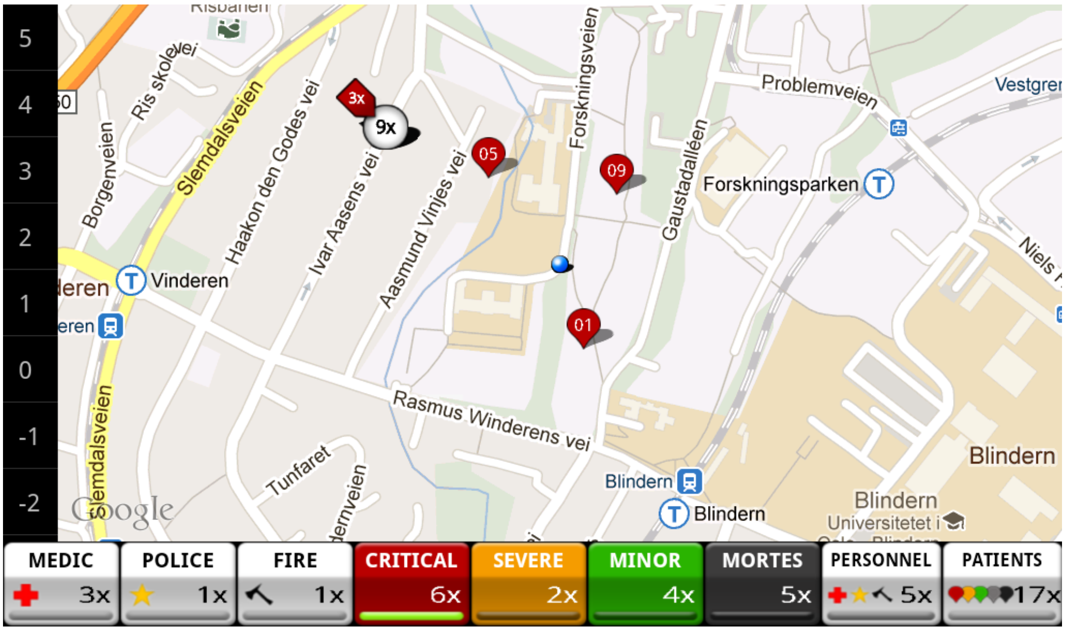


Figure 26 – Here only 'CRITICAL'-patients are visible because all other units have been toggled off. Feedback of which button is selected is provided through the green and gray bars on the bottom of the buttons.

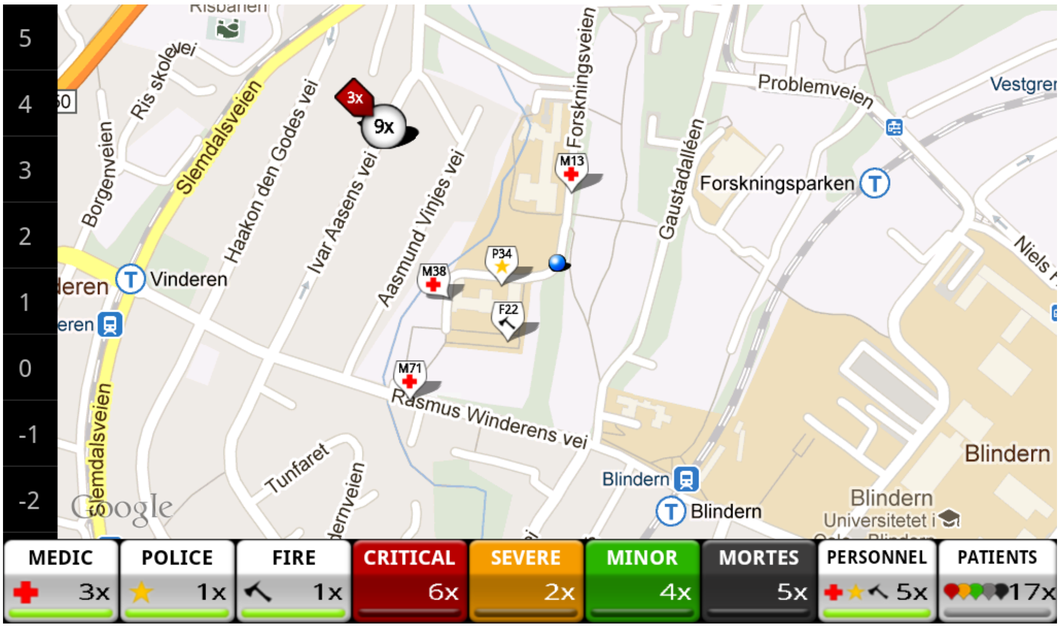


Figure 27 – Here the 'PERSONNEL'-button is toggled on, while the 'PATIENTS'-button is toggled off. See how each personnel button is toggled on while each patient button is toggled off providing feedback of what is currently being filtered in or away.

Icon interaction

When operating the interface the OC should be able to contact personnel and see information about him/her, i.e. ID and rank. S/he should also be able to send personnel to a patient through the interface. Information about whom and what is covered in a cluster should also be made available. (See Figure 28, Figure 29 and Figure 30).

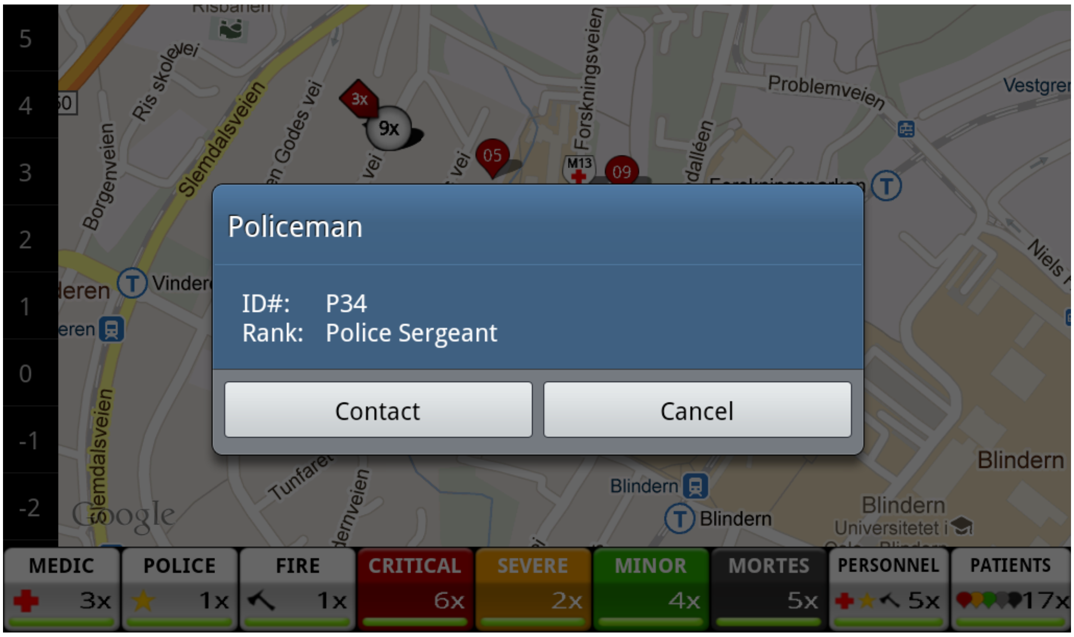


Figure 28 – This is the current dialog box that one will get while pressing on a 'POLICE'-officer icon, in this case the 'P34'-icon. Additional information can be provided, and further research is suggested to uncover what information is needed amongst Operational Commanders. The boxes are similar for 'POLICE' and 'PARAMEDIC'-icons as well. A button for 'Contact' is also implemented to illustrate the possibility of contacting emergency personnel directly through this interface.

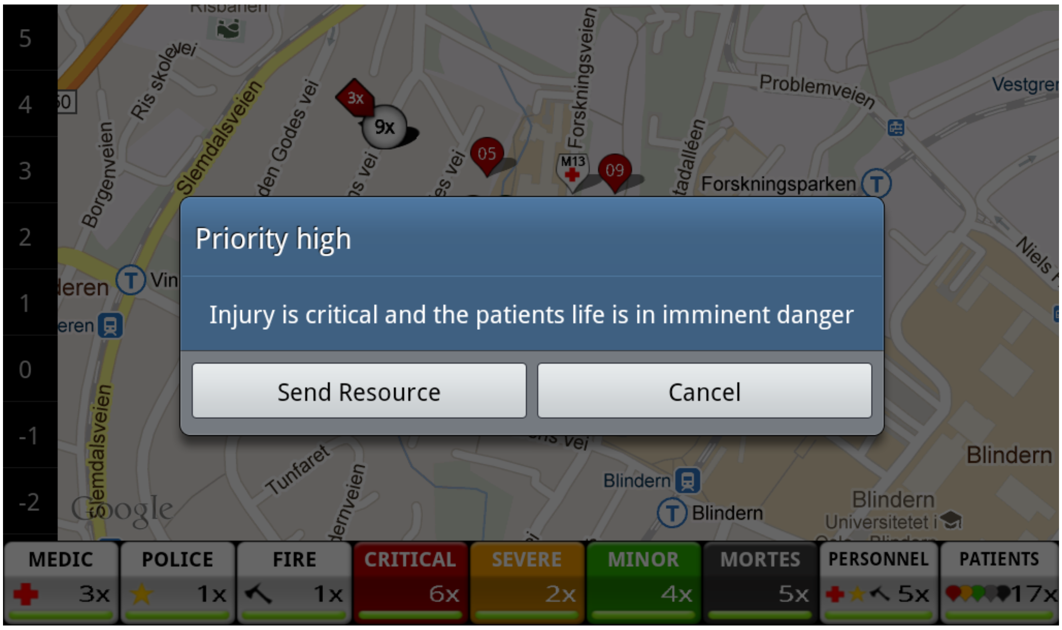


Figure 29 – When clicking on a 'PATIENT'-icon this dialog box appears. The text 'Priority high' and the help text are chosen because it will further explain the priority of that patient if the colors should not be understood. A 'Send Resource'-button illustrates how personnel can be allocated to the chosen patient.

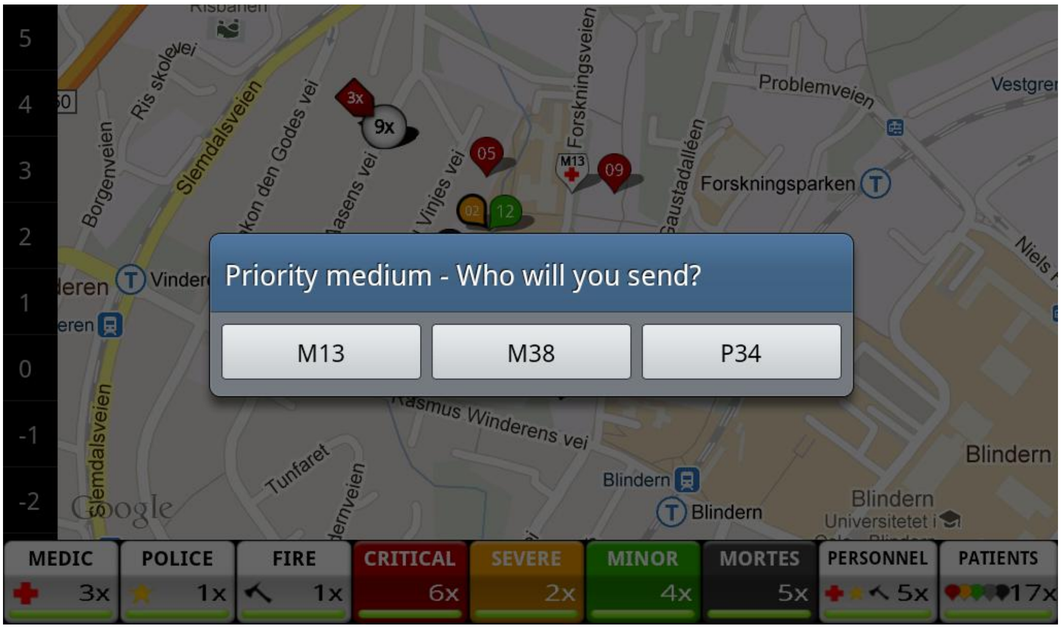


Figure 30 – When clicking on the 'Send Resource'-button shown in Figure 29, a new dialog box appears. Here available personnel can be selected. This is just meant as an example and further development and testing should be carried out before this functionality can be considered satisfactory. For resource allocation we can look to [34] for inspiration.

11 Discussion

In this chapter we will discuss findings and challenges that have arisen during this master project. Theory and experiences will be combined to promote further understanding of the choices made and the implication these choices will have. There has been however already much discussion earlier in this thesis, and to avoid repetition will not all of these discussions be mentioned here.

11.1 Validity and reliability

Validity is concerned with whether or not the research conducted measures what is intended to measure [6]. Reliability refers to question of whether the results of the methods would be the same if one decided to redo them under similar circumstances [6]. All research should strive towards enhancing validity and reliability to maximum levels. It is however a very difficult task.

Knowing whether or not a method provides great validity or not is a matter of knowledge and experience. Different methods are known to have implications to validity, but many methods differ regarding in what way. Direct observations for example are known to bias the subjects being observed, making them act differently than they normally would. This is known as the *'Hawthorne effect'* [6]. Observations are also biased by what the observer expects to find because there is normally too much happening for the observer to see it all. The expectations of what is of most importance works as a filter which makes researchers prone to 'filter away' important data. One way to enhance the validity of the data gathered is through the combination with other techniques, what is known as triangulation (See Chapter 3). One methods weakness can be covered by another method which has another weakness: - In interviews people are known to say something that differs from what they actually do, while this is uncovered by observations. Observations however reveal nothing of what users' think, something that interviews are excellent for. Additionally we should emphasize that although two individuals are defined as being in the same user group this does not mean that they would behave similar during the same observation. Involving different users is therefore of importance.

In this master project observation has been triangulated with both interviews and document analysis of other major incidents, i.e. the Åsta-accident and the incidents of 22th of July 2011.

The effects of triangulation also apply to reliability. Using many different methods can better reveal what data is consistent and what is not. Consistency of data is also a matter of research approach. Whereas structured interviews searches for specific answers that are more easily replicated should the research be repeated, is open-ended questions of less reliability. There is a trade-off here. Emphasizing reliability would provide more consistent research data that is generally more accepted in research communities. But this emphasis will also strain the explorative nature of research conducted with open-ended interviews and will reduce the chance of uncovering something totally unexpected. Reliability can be achieved in explorative research though, but it requires a use of multiple methods and thorough data collection that we did not have the time for in this master project.

Both the validity and the reliability of this master thesis can be criticized of being unsatisfactory. Testing the final prototype in only one work-domain expert usability test is not enough to ensure reliability of the feedback. As discussed in Chapter 3.4.1 the generalizability is not the focus of this master project and the data collected should be treated accordingly. However, efforts have been made to enhance validity and reliability through the use of triangulation. Testing and evaluations has been conducted to ensure that the design is not a result of only the designer's mental models but rather a result of a large group of different individuals. Different users, family, friends and fellow students have contributed to this process and it is therefore not a result of the designer's imagination alone.

11.2 Meeting the needs

Through the use of electronic tags and visualization on mobile devices a new system for information sharing has been suggested. It was observed that a lot of the communication being done over the radio was that of personnel and patients positions and statuses. This information has been in the suggested system visualized through the use of GoogleMaps, text and icons. A prototype interface for paramedical Operational Commanders has been designed and developed iteratively (See Chapter 7 - 10), and was evaluated by a work domain expert (See Chapter 9).

In Chapter 6.1 we defined three needs for the system designed in this master project. We will now shortly discuss their status at the end of this thesis work.

Need #1: Reducing the strain on the emergency radio

It was confirmed by the OC in the final evaluation, as well as through the observation in Stavanger and by the experiences from Utøya 2011, that the verbal communications system utilized today does not have the capacity of handling major incidents. Visualization information that is today communicated verbally will ensure that one is less reliant on the radio and the OC confirmed that the suggested system will reduce the strain posed on it considerably. Functionality for filtering away information that is regarded as unrelated to the decision at hand will enhance efficiency because it will reduce the amount of information the user has to process. Grouping and structuring information further enhances the efficiency because it is easier to determine what information one needs to consider if one is able to understand what groups of information are unrelated to the decision at hand.

Need #2: Reducing the vulnerability to noise

Another effect of visualizing information is that one can use the eyes instead of the ears to acquire it. This means that environmental noise does not influence the information provided through this system. We can thereby say that the vulnerability to noise is greatly reduced by the system suggested in this thesis. This was confirmed by the OC to be a great improvement compared to the communications system utilized today. The system suggested here does however rely on visibility. If something, for example a snow storm, should make it difficult to see the screen on a mobile device is radio communication a better choice. The system suggested here should therefore not *replace* the emergency radio, but rather *compliment* it.

Need #3: Creating a new system for triaging

"*Central health authorities has to ensure that a consistent national system for triaging of patients is introduced*" [3:16].

The suggested new system for triaging involves electronic tags which can communicate its position, ID, type, and status. This information is wirelessly communicated to the system and it can then be visualized in system interfaces. The OC interpreted this as a good way to perform a triage and emphasized that the tag should be locked to each patient so that it cannot be stolen. Further research on the design of the tag is needed, both regarding physical hardware design as well as interactional hardware design. The status of the tag should always be visible, and personnel should be able to change the priority level if needed. Patients should however not be able to do this. Possible ways to ensure that only personnel can change this value should be explored by hardware experts.

The suggested four-level color-based priority terminology has proved to be intuitive and satisfactory to both peers and end-users (See Chapter 6.2.1). The fifth color 'blue/gray' was removed because it was perceived as irrelevant and confusing (See Table 2 and Table 4).

11.3 The need for a new communications system

The collaborative training exercise in Stavanger revealed that the amount of verbal communication exceeds the capacity of the Operational Commander. Personnel had to wait for the radio to be available before being able to use it for their own communication. The large amount of information shared over the radio also made it difficult to distinct the information that was relevant for oneself apart from information that was not. This was also experienced during the Utøya-operation confirming a need for enhanced communication systems [3]. Furthermore, due to the amount of noise created by the helicopter it was discovered that the communication amongst personnel is fragile to environmental noise. Based on these observations the verbal communication utilized today should be supplemented with other ways of communicating. We can also note that the use of speech/sound based user interfaces such as suggested in [10] would also be vulnerable to environmental noise and will therefore not be recommended for paramedics in larger emergency operations.

Based on these observations, new ways in which this information could be communicated through the use of visualization is suggested. By designing an intuitive interface where this basic information is provided might help reduce the workload on the Operational Commanders thus reducing the need from two OCs to one. Functionality for filtering away information that is not relevant for the decisions at hand enables the OC to quickly determine how the resources should be organized. The effect of visualizing information that today is communicated verbally will reduce the amount of radio traffic considerably, thus reducing the chance of information overload. This in turn will possibly make it easier for personnel to distinct information relevant to themselves from information that is not.

It was also discovered that the system utilized today, based on paper maps and radio communication, does not provide a real-time overview of the situation. Any changes to personnel and patients statuses or locations have to be communicated verbally and the map has to be updated manually. Being able to get a real-time overview of the situation was in the interview with the OC regarded as a major improvement to emergency management (See Chapter 9.1.1).

11.3.1 Overview of resources centrally

The functionality of real-time situational overview is not only interesting for the personnel in the field. The emergency central and hospitals would also benefit from getting an overview of the current situation. The incidents 22th of July 2011 uncovered a need for better systems that will provide an overview of paramedical resources across regions and establishments [3]. Although the emergency centrals are currently using a system called TransMed which provides an overview of resources it was found to be unsatisfactory. The lack of a common overview which is shared amongst the emergency centers prevented necessary coordination between these centers [3], and therefore an improved system is suggested. The interviews from Oslo and of the OC suggested that hospitals would benefit from seeing how incidents are evolving so that they are better able to prepare themselves and delegate patients to other hospitals if necessary. Several of the involved hospitals of 22th of July 2011 reported that they after being alerted did not receive additional information other than through media [3]. Expanding the system suggested in this master thesis and provides desired overviews both for hospitals and the emergency central would certainly be possible. These interfaces should however be tailored to the needs of the units since their needs probably will not be the same as that of the OCs.

It is worth noting, although this is not a central part of this thesis, that radio communication is very vulnerable inside buildings due to limited signal coverage. A system which does not rely on direct verbal communication could queue information fed to the system until the signal again is available. On could therefore still be able to receive all information provided even without network coverage, even though it would be delayed by the length of time that there is no signal coverage.

One way to improve network coverage could be to create beacons that could transport the signal from one beacon to the next until the signal coverage is available. Personnel could possible wear these beacons and/or they could be placed on the ground at strategic locations. There is currently ongoing research at SINTEF ICT exploring how such beacons could be designed and used.

11.3.2 Medical sensors

Tagging patients with sensors that register a patients health status is something that might prove to be life saving. Tags with this ability could register whenever a patient's condition might change and would therefore provide real-time information on which the organizer should prioritize. As discovered in this thesis however the medical sensor technology is currently not developed enough to be used for this purpose (see Chapter 6.3.1 for a fuller discussion). Sensors for registration of body temperature are not accurate enough unless they are located inside a patient's body, something that is regarded as a bad idea considering for example the lack of a sterile environment. Sensors for registration of heart-rate and breathing have to be attached to the torso of a body, something that is time consuming for the person attaching the sensor to a patient. Furthermore one would have to get below the clothes of a patient to apply the sensor posing risk of hypothermia for the patients during cold and wet weather. An emergency management system would have to be usable in any type of weather if it is to be implemented.

If sensor technology should develop to be accurate in registering body temperature, heart rate and breathing or oxygen levels in the blood stream by for example attaching the tag to a patients head, one should start developing tags with medical sensors. This data is undoubtedly interesting for the managers of emergency personnel.

11.4 Usability goals

Here I will discuss how the usability goals presented in Chapter 4.1 have been met.

Efficiency

The usability goal which was given the highest priority during this master thesis was the goal of efficiency. Making a system which is in it self quick to use was the primary goal. However, it was also desirable to design a system which could enhance the efficiency of emergency operations in general. Although no full scale testing has been completed during this master thesis due to the limited time-frame available, we can – based on the evaluations of an Operational Commander and through the understanding of how major incidents have been organized earlier – say that it is very likely that this system will in fact be both efficient to use and enhance general efficiency in larger emergency operations.

Choosing to group the ‘number of units’-indicator within the button corresponding to that category enables users, considering Hicks Law, to quickly filter out irrelevant information and therefore process information more efficiently – thus increasing management efficiency. Being able to filter the information visualized in the interface further enhances efficiency. Not all information is relevant to a decision and the ability to remove this information from the interface will enable the OCs to quickly understand the options available related to the desired goal s/he wishes to accomplish [7]. The toggling of categories of units in the interface is regarded as a filtering functionality reducing the amount of information to be processed to a level that is perceived as appropriate.

Memorability

Testing memorability is something that would require more time than what was available after the completion of the final prototype. Thorough testing of this would require subjects to fully learn the system and then be given the opportunity to forget it by waiting a certain amount of time, preferably the same amount of time that real end-users waits between major incidents, which can take years. There are however some indicators that could reveal if the system is easy to remember or not. One of these is that of logical and sensible structures, which is described in (See Chapter 4.1). Opportunistic evaluations and the evaluation of the OC suggested that elements are logically positioned and that their structures are appropriate.

Using the terminology and semantics of paramedics when creating the different categories in the user interface enables the OC to better understand and remember how the system operates. This ensures consistency with the general practice of paramedical work, thus reducing the amount of information users has to remember. If the system would use completely new priority-scales, for instance, the users would have to remember these in addition to the one they use on a daily basis.

Learnability

Learnability was also emphasized in the design of the system suggested in this master thesis. This has many reasons. One has to do with economy. Reducing the amount of training needed to operate the system would make it cheaper to implement and also therefore more likely to be chosen amongst competing systems. Another reason is that it allows users to forget parts of the system and still be able to quickly re-learn how to operate it without training.

The main reason however is that it should be as easy to operate as quickly as possible thus reducing the amount of time used trying to understand the system and rather just utilize it for information sharing and gathering. Emergency work is extremely time dependent and if the users perceive that the system is difficult to learn and that it might take valuable time they will rather just use the systems they are familiar with.

Many factors influence the learnability of a system. A clear conceptual model, which is described in Chapter 4.2, and a good mapping of actions, which is also described there, further enhances the intuitiveness of the system making it easier to learn [4]. Buttons should look like buttons and act like buttons. When designing these elements it is a good strategy to utilize what people are already familiar with so that they instantly recognize the function of the element [4]. In Android buttons are usually square with rounded corners, and they were therefore designed in that way in this interface. They should afford the toggle-functionality, something that is communicated by the green bar on the bottom at the buttons (The bar is green representing 'ON' and gray representing 'OFF'. The color was chosen because it resembles the color used in Android toggle-buttons. The color of the 'location-icon' was inspired by the color of location icons in different map-apps like the Android apps 'Maps', 'Navigation' and 'Modern Compass'. The shape of the icon was inspired by the latter two.

Making the categories consistently distinctable from each other further advances the learnability by making it clearly visible what relates to one another and what does not. The resource icons and buttons are therefore made distinctable from the patient icons and buttons, and every icon-type is again distinctable from the other types through the use of colors and symbols. Using the same colors and symbols on the buttons relating to the icons in the map further enhances consistency and increases the predictability of the interface. This again ensures that the learnability of the system is advanced.

Effectiveness

The OC and trainee in the final evaluation both regarded the system suggested in this master thesis to be far better for managing larger emergency incidents than the one they operate with today. They perceive it as less vulnerable to noise and as more robust when it comes to handling the large amount of information shared than the radio based system utilized today. The functionality of allocating personnel through the interface of the OC would further reduce the strain on the emergency radio and was desired. Based on this feedback we can say that the system does what it is meant to do well, and that its effectiveness is satisfactory.

Safety

It is not yet uncovered any dangers posed to the personnel by the system suggested in this master thesis. It is however a question that should be emphasized when designing the electronic tags to be attached to patients. These can, if designed wrong, pose serious risks to a patients health. Attaching something around the neck of a patient for example will pose a serious risk of strangling, and attaching something to for example an arm could cause the bloodstream to be cut of posing serious risks to the limb. In addition the hardware should not be sharp, toxic, flammable or explosive as this of course poses serious risks to any individual nearby. Additionally the equipment should be ergonomically harmless for the personnel operating it. If it is too heavy or needs to be carried around in awkward ways it could potentially harm the personnel's physical health.

The consequences of using the system and interface wrongly is not considered to be of fatal consequences in other areas than the applying of a tag to a patient. The fear personnel perceives of the consequences of errors occurring when using the system wrongly has not be discovered to be a factor at all, but has not been emphasized in this research.

Utility

The system suggested in this master thesis provides a wider range of functionality than the one used today. To provide a better overview of similarities and differences regarding the utility both systems provide I have created a table (See Table 5).

#	Utility	Todays system	Suggested system
1	*A map based overview of the incident*	Yes – Paper based maps	Yes – An interactive map
2	Visualization of personnel and patients in this map	No – But the Operational Commander can draw in the map if desired.	Yes
3	Real-time overview of number of personnel and patients in the area	No – The organizers has to remember this by listening to the emergency radio.	Yes – this is provided automatically without the need of radio communication
4	Real-time visualization of personnel and patients statuses and priority	No	Yes
5	Real-time visualization of personnel and patients positions	No	Yes
6	Information filtering functionality	No – The organizers has to listen to all the information shared on the radio channels	Yes
7	Functionality for resoruce allocation	Yes – Only through the use of radio communication	Yes – Through the interface and through the use of radio communication
8	Functionality for one-to-one communication	No – But personnel have used private mobile phones to achieve this. Being private they are not regarded as a direct part of todays system.	Yes – Through the use of text messages. However, this has not been fully researched. Pre-defined text-messages has been suggested. Mobile phones can also be used.

Table 5 – Utility differences between the management system used today, and the one suggested in this thesis

As we can see from the table there is no utility being lost if one should replace the system used today with the system suggested in this master thesis. All of the eight utilities have been discussed with the end-user and are regarded as desirable.

11.5 Scalability: From daily use to major incidents

One of the major challenges a system for larger incident faces is that of scalability. The users during this master thesis have emphasized the importance of daily use to ensure that the paramedics are familiar with the system when major incidents occur. In other research the need for day-to-day use is regarded as a top priority when designing for emergency personnel [15], and the system is regarded as unlikely to be used if it is not operated on a daily basis [5].

Underlining the importance of experience it might be relevant to explore Clark Hulls version of drive theory. He states that the strength of a behavior is a product of the subjects habit and drive [16]. The subject in this case being the user, habit referring to experience and training, and drive meaning motivation to complete the task. The strength of behavior in this theory refers to the quality of the actions chosen and performed: *"Strength of behavior = Habit * Drive" [16:456].* It is possible to argue that the drive of emergency personnel is generally high and that the experience therefore is the key to improving personnel actions.

Higher levels of training and experience also reduce the level of stress an individual experiences. Reducing the amount of stress amongst personnel helps reduce the likeliness of errors being made [14], further arguing for why emergency personnel should be experienced with the system if they should use it in major incidents.

There are however limits to how scalable a system might be. The system designed in this master project emphasizes major incidents, and it is unlikely that the paramedics will need such a system for every incident they encounter. The vast specter of different incidents and mission types that paramedics are involved in is difficult to design for. However, introducing text-based messages for reporting purposes, inspired by the ones provided by the LOCUS system combined with further research, could increase the likeliness that the system will be used on a daily basis. This would for example enhance the amount of logging conducted.

11.6 Automatic logging

As previously mentioned there is currently a lack of data on how emergency response operation was organized due to a poor system for logging [2, 5]. The reason for the current log not being satisfactory is that it demands the attention and concentration of emergency personnel for any data to be recorded since it is based on writing on paper and on recording radio traffic. As mentioned earlier emergency personnel are generally unwilling to direct their attention to anything that does not have something to do with the current emergency operation [5].

Managing a large incident with the aid of a computer-based management system such as the one suggested in this thesis might prove to log the information that is currently not logged. This information includes where patients and personnel are located at any given time, what orders are given, how many resources and patients there are in any given moment and what status they have at that time. The system could automatically log when and where patients were found and track every movement of any person – both personnel and patients. It could even tell who tagged which patient. Having these data could provide new insights into how future emergency incidents could be even better organized.

11.7 Weight of the equipment

We should add that the tagging equipment has to be light. The weight of the ambulances is close to the legal limit and is not able to bring along a heavy system. The equipment will naturally be more likely to be used if it could be brought in every emergency vehicle. Tagging a multitude of patients in the field also means that the personnel have to be able to carry many tags unobtrusively meaning that they have to be light and small. Furthermore, the triaging equipment has to be usable by all personnel. As was learned in Stavanger and in the Utøya-incident other personnel than paramedics perform the triage when the incident area is considered to be unsafe [3].

11.8 Programming in Android

Prior to this master thesis work I had no experience with Android as a programming platform. One of, or rather the main reason for choosing to include this in my thesis work was that I desired to acquire the technical competence so that I would be more attractive in the eyes of employees. My technical programming background consisted of only two java courses; 'INF1000 – Introduction to object-oriented programming' and 'INF1010 – Object oriented programming'. I would in retrospect argue that having only these two programming courses is a thin foundation when choosing to develop a high-fidelity prototype as a supplement to a master thesis.

I had not used an IDE before (Integrated development environment). Since Eclipse is a free and open software, and since it was suggested in [18] I decided to use this program when developing the prototype. As I have no experience from other IDEs it is difficult for me to say if it is a good IDE program or not. Generally I feel fairly satisfied. In many respects it works well. I did however, on many occasions, experience errors that were not explained in any ways. The poor quality of the error messages caused the loss of a considerable amount of time. On one occasion I sat half a day with an error that suddenly occurred. I tried to erase all code back to the point where I knew it should work and still it didn't. I tried to find the answer in forums on the internet and tried hundreds of suggested solutions. Finally, after many hours of error hunting I came across a suggestion that turned out to reveal the error; the cache of Eclipse was full and the project had to be *'cleaned'*. When this was done everything worked as before. The part that makes this irritating is that it seemed as if the problem was located inside *my* code through the feedback provided. It is fair to say that errors like this one causes a lot of unnecessary frustration and that it damages the user experience and reputation of the IDE. As an interaction designer I would say that Eclipse has a way to go when it comes to feedback.

Regarding the dissertation as the main part and the programming work as a secondary part I would say that the amount of time spent on learning how to program a map-based high-fidelity prototype in Android has been a significant expense to the time available for writing the dissertation. Choosing to utilize only low-fidelity methods like paper-based prototypes and wireframes in the communication with the users would allow for more time on the academic aspect of the thesis and could thus have increased the theoretical quality of the thesis.

I do not however regret the decision to emphasize the development of a high-fidelity prototype and the learning process which followed on the basis of two things. First, the evaluation and communication of the conceptual model and design choices would not have had the same validity or reliability if for example paper-based prototypes had been used. This is because these prototypes rely to a greater extent on the user's ability to imagine how the end product would be. A high-fidelity prototype is closer to the end result allowing the users to test and feel what it is like using the system instead of just imagining it. The second reason for not regretting the decision is that I actually *did* learn how to develop interfaces in Android. This competence could indeed separate me from the crowd when applying for a job. The hard work invested into acquiring this competence has therefore been worth it.

12 Conclusion

In this chapter I will shortly present what has come out of this master project. I will answer the six question presented in Chapter __ that was also discussed in Chapter 5.3 regarding the system used by paramedics today. The answering done in this chapter will consider the system designed in this master project. I will also summarize what my contribution to the research community revolving emergency work is.

In this master thesis we have investigated the following: '*How can mobile technology help improve resource management for paramedics in larger emergency situations?*' Based on the data gathered through different research methods we have been able to find out how resource management is done today. Analyzing and interpreting the data have enabled us to derive some design implications and to design a system for resource management for paramedics based on mobile technology. These implications has then been considered and translated by the researcher into a systems description and a prototype UI for the operational commander.

We have discovered that mobile technology offers great potentials for improvements for resource management for paramedics in major incidents. Based on the user input, observations and review of incident documents we were able to identify a need for a new communications system. The radio-based system utilized today does not provide the capacity needed for handling the amount of information exchange that occurs in major incidents, and is furthermore vulnerable to environmental noise produced by for example helicopters. Based on these observations a new communications system has been suggested. The system suggested relies on visualization of information on mobile computer devices and on electronic tags that are attached to the patients and personnel. The real-time and accurate overview of the incident area in addition to the reduced strain on the emergency radio are both regarded as significant improvements to the resource management of paramedics in major incidents. This statement is based on the evaluations of work-domain experts that evaluated the system in a cognitive jogthrough combined with an open-ended interview (See Chapter 9).

12.1 Answering the six questions

Earlier in Chapter 5.3 we answered six questions based on the system utilized today. Now it is time to answer these questions based on the system designed in this master thesis:

For resource management of paramedics, what is the system?

The system suggested in this master thesis uses tags with electronic microchips that are distributed by the triager. The tags communicate their own geographical position through the use of GPS, as well as their priority status and unique ID. The data from these tags is wirelessly sent to the user interfaces for the operational commander, as well as the interfaces for the paramedics. Both of these interfaces are map-based and displayed on mobile devices.

The operational commanders UI shows all patients and resources in a map, also displaying the current number of each unit type. It can provide functionality for contacting each resource personally both verbally and textually. The interface enables the operational commander to send any resource to a patient without the use of verbal communication. It also has filtering functionality for hiding any groups of elements desirable.

The paramedical UI primarily shows the direction and distance to a patient which has been given to them by the operational commander. It also discretely shows other patients and resources in the field, so that it is easier for the paramedic to orient him/herself in the field.

What is the environment in which emergency response occurs and what is the relation the system has with its environment?

The environment of emergency response is extremely varied. It can occur in extreme temperatures, in wet and dry conditions, in dirty areas and so on. These are however hardware challenges that is not the main focus of this master thesis. They should however be emphasized if this system is to be implemented.

There are however three great environmental challenges to the new system that are considered here. The first is that of GPS and radio signal coverage inside buildings and tunnels. The second is the challenge of different floors inside buildings. Being able to see where patients are located inside a building is important for the management of personnel. The third challenge is noise. When environmental noise is loud, like when a helicopter is present, the verbal communication is severely limited and can even break down.

Ensuring that the system supports satisfactory communication also when these challenging environmental factors are present is important for the quality of the emergency management process. All of these challenges have been discussed in this thesis and different solutions have been suggested. The visualization of information allows for information sharing in noisy environments, a floor/layer selector ensures that the Operational Commander can navigate and see which floor personnel and patients are located at, and the signals could be enhanced through the use of signal beacons.

What is the feedback provided by the system, both of statuses and errors?

The system communicates patients and resources positions and statuses, as well as the number of each unit automatically and in real-time.

To detect errors functionality for visualizing if a tag stops sending signals has been suggested and should be implemented in future development of the system. The suggested visualization of this occurring was to color the affected icons with a gray tone and to make them blink. This is because it is considered as important information and should catch the attention of the OC as quickly as possible. A tag that stops sending signals could indicate that something special has occurred. I could for example be destroyed by an explosion or fire that is spreading.

How does the system measure when it has achieved its goal?

It is easy for all personnel to see how far the operation is from finishing, and when it is finished with the suggested system. If there are no more patient icons in the map, there are no more patients present.

Who monitors the system?

Primarily the Operational Commander. But also the personnel are now able to view the situation through their own interface. As discussed in Chapter 11.3.1 the system could be interesting for hospitals and the emergency central as well. This is suggested to be further researched in Chapter 13.2.

Is the system meeting the needs of its users?

Yes. The evaluation with the work domain experts (See Chapter 9) suggest that the system is better for emergency management than the one used today. The system was perceived to be easy to understand, easy to operate and highly efficient. The evaluators thought that this system could both increase the total efficiency of emergency operations as well as the quality. The real-time overview of the situation was considered to be highly desirable and the reduction of the traffic on the emergency radio was considered to be sorely needed. The evaluators explicitly said that "*you have really uncovered a need that we have, and you are really onto something here*" (By the Operational Commander, from the interview with the OC (Translated by the researcher)).

12.2 My contribution

Through this master thesis I have explored how communication is handled in emergency operations today amongst paramedics and their organizers. I have pointed out that it is mainly verbal and that the amount of information that is shared over the emergency radio in major emergency operations exceeds the capacity of this technology. Furthermore I have found that the verbal communication system used today is vulnerable to environmental noise and that for example helicopters can paralyze the communication completely in smaller areas by the amount of noise it produces. Additionally I have discovered that the amount of information which emergency personnel, especially Operational Commanders, have to process exceeds the users' processing capacity.

Based on this I have discovered a need for new communicational tools and routines during such incidents. Using visualization on mobile devices and creating a new system for triage in major incidents, I have suggested a solution to these communicational challenges. Using the terminology and routines currently employed by paramedics in major emergency operations today I have been able to design a suggested interface that has been evaluated by users to have both good learnability and good efficiency.

13 Future work

In this chapter future work will be presented. When trying to answer the research question in this master thesis many new questions arose. Some of these have been answered, but there are many that need further research. In this chapter I will point out some areas that need further research.

13.1 The interface for the Operational Commander

The prototype of the Operational Commanders interface is just a prototype used to communicate the system and the conceptual model to the users and needs further development until it can be considered to be satisfactory enough to be implemented. These are summarized in short here.

Resource allocation

The functionality for resource re-/allocation should be developed further. The 'pop-up' text box that is used for the prototype is not optimal because it blocks the users overview of the incident area making it difficult to see for example who is close to the patient and therefore who should be sent. Positioning the box in another area of the screen could be one possibility. Selecting a resource directly in the interface instead of using 'pop-up' text boxes is another alternative.

Manual movement and placement of icons

In some cases, as discussed in Chapter 2.4.5, the accuracy of the location technology is poor. Therefore, if the Operational Commander knows where a resource actually is and this does not correlate with where it appears in the interface s/he should be able to manually move the icon into its correct position [10]. This is also needed should the signal coverage break down due to for example large buildings, tunnels or mountains.

Researchers should explore how the movement of icons is designed in already existing technologies that supports this feature, like for example the 'desktop screen' of android devices or iPhones.

Algorithm development

When trying to select a resource the test subjects often struggled to hit the correct icon if two icons were overlapping. Implementing automatically rotating icons is therefore extremely important. When the icons did not overlap the accuracy was not observed to be a problem.

The icons to be used for this purpose have been designed in this master thesis, but the algorithm needed for this to happen automatically is not. Another thing the algorithm needs to include is the aggregation into, and from, cluster icons.

When zooming in and out in the map icons overlapping each other even when rotating should automatically be aggregated into a cluster icon showing the number of icons that are aggregated into that cluster and how many within the cluster there is of the type with highest priority. The cluster icon should dissolve into smaller clusters and/or individual icons at the zoom level that allows these icons to be displayed without any overlap.

Research into how this algorithm should be developed is therefore suggested. The algorithm should not reduce the efficiency of the system and should be tested thoroughly to avoid any errors.

Developing intuitive information texts

The texts related to each icon should be further developed in cooperation with work domain experts. The texts should be there to provide extra information about resources and/or provide explanations where something is unclear. The texts should be intuitive, appropriate and as short as possible. Researchers should emphasize the users' language and terminology.

Zoom and animate to

Functionality should be included in the interface of the operational commander and the personnel in the field to find specific personnel or patients in the map and automatically zoom and animate to their position. Functionality for animating to ones own position should also be provided, as well as functionality for zooming to overview that includes all resources within the scope of the interface. This functionality is important so that the organizers can easily determine what the incident area is and so that they can find patients or personnel that is currently in focus.

Designing icons for signal error

If tags should, for whatever reason, stop sending signals to the system it is important that it is clearly visible in the interface of the Operational Commander [10]. Visualization of signal errors should be explored and developed. A tag that stops sending signal could mean that the tag is damaged. This could be either because of hardware error or it could be an indication of for example an explosion or fire that has consumed it. Whether icons should change in shape, color or begin a pulsing animation needs to be discussed and tested to uncover what is the most intuitive way in which this can be communicated.

13.2 Other areas of focus

Designing the tags (Hardware design)

There is a need for further research into how the electronic tags suggested in this master thesis could be designed. As described in Chapter 6.3 the tags should know their location, ID and priority level and should be able to communicate this to the system wirelessly. They should be easy to apply for the emergency personnel, but the patients should not be able to remove them from other patients. This is to prevent tags from being stolen or lost. The tag should display the patients priority color and ID clearly. The priority level should be changeable only by emergency personnel and not by patients. The hardware designer should focus especially on efficiency and safety, making the tag quickly and easily applicable posing no risk to the health of neither patients nor personnel.

Furthermore, it is important that the emergency personnel are able to carry many tags when triaging an incident area. If the personnel have to run back to the ambulance to collect the tags it is less likely that they will use them at all. This observation is based on the comment in [5] that says that emergency personnel will only use equipment that they perceive as appropriate for dealing with the patients at the scene. Spending precious time running back and forth between the ambulance and the incident area is likely to be considered a less than appropriate way to spend critical time at an incident site.

Availability of building maps

Maps and blueprints of buildings should ideally be available in the user interface of, in particular, the Operational Commander. Research is needed into what is legally as well as practically possible regarding the availability of digital maps. Any available map that is legal to include in the system should be implemented into the system. The need for building maps was pointed out by the Operational Commander in the usability testing in Chapter 9.

Designing a user interface for emergency personnel

In this master project we have designed an interface for the Operational Commander during major emergency operation. We have in Chapter 6.4.2 suggested an interface for emergency personnel. This is only a suggestion and can be considered as inspiration for further development. No testing of this interface has been conducted, although it was briefly evaluated by the Operational Commander in the usability testing described in Chapter 9. Further investigation into finding an optimal interface for emergency personnel is suggested. Different modalities and new technologies should be explored to find out how the incident information should be presented. Augmented reality is another technology that could be interesting for further research in the context of the system suggested in this master thesis.

Designing a central resource overview system

As has been discussed in this master thesis there is a need for a better system for real-time resource overview in hospitals and in the emergency central. It was suggested by the work domain expert in the usability testing that the system suggested in this master thesis could be of interest for these institutions as well. Based on this input further research into how these interfaces should be designed and what kinds of functionality and modality they should have is suggested.

It is important here to investigate what needs of the different institutions are. Especially hospitals will have less need for resource allocation and re-allocation than Operational Commanders or the emergency central. Although these user interfaces are likely to be different they should all be part of the same system and it is therefore suggested that this research is conducted amongst cooperative researchers.

Defining reporting messages

The users suggested that pre-defined messages could be used for reporting purposes both in daily, as well as during major emergency operations. Research into what these pre-defined messages should say, and how many alternatives one should implement is needed before this functionality could be implemented. Researchers should investigate the vast specter of different tasks that paramedical workers perform and create messages that will cover as many reporting needs as possible with as few choices as possible.

Improving the icon alteration

The bordered icons used to visualize un-/available personnel and patients were not immediately discovered by the users of the interface. They had to be told that the icons changed before they were able to see it. Patient icons were later evaluated to not need this alteration feature. Designing a more clearly visible alteration of the personnel icons that is intuitively understood as ‘unavailable’ is therefore suggested.

Medical sensors

If great advances in medical sensory technology allows the electronic tags suggested in this master thesis to record medical data from patients and personnel, should research be conducted into how these tags should be designed. This implies designing the hardware device and the way in which it should be applied as well as designing a user interface for displaying this information to the users of the system, e.g. the Operational Commander. The medical data that is considered as interesting includes breathing rhythm, pulse, oxygen levels in the bloodstream and body temperature.

Different screen sizes and modalities

Today there is a vast array of different mobile devices offering practically any screen size desirable, and which offers many different modalities. Touch screens enables the user to directly interact with the screen without needing any additional equipment like a mouse/keyboard or a stylus. The fingertips are however of a considerable size making them less accurate when trying to press an element in a screen than for example a mouse pointer or a stylus. For collaborative interactions with a user interface multitouch tables supports multiple users simultaneously, something that is not offered by many other touch screen devices.

In this master project we have used the Samsung Galaxy GT-P1000 tablet which has a size of 19 x 12 cm and that has touch screen modality. This device was chosen based on its availability (Since I already owned one), and on the assumption that its size would make it mobile whilst still offering a large enough screen to clearly visualize the incident area and the elements within it. This has however not been empirically tested and alternative screen sizes and devices have not been elaborated.

Optimalizing screen sizes for different user groups is suggested because of the different needs these users have [10]. Paramedics working in the field are for examples in need of non-intrusive devices that provide information specific to them, e.g. information about the direction and distance to the patient they have been given. Operational Commanders on the other hand need information about the whole emergency operation and need an overview of the incident area with every resource visible [10]. The OCs and other incident organizers might also need modality that supports multiple users interacting in the interface simultaneously. Hospitals and the emergency centrals might again have different needs also posing implications on what kind of screen size would be optimal.

Empirical data and testing of different screen sizes and modalities are recommended as further research and should be conducted prior to implementing a system such as the one described in this master thesis.

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15 Appendices

Appendix 1.
- Written consent form

Informasjon og Samtykke

Prosjektet

På vegne av SINTEF og Universitetet i Oslo vil Erik G. Nilsson (PHD-studie) og Mads H. Jahren (Mastergrad-studie) utføre to intervjuer av ambulansepersonell i forbindelse med prosjektet EMERGENCY. Prosjektets formål er å forbedre og utvikle støtte for avgjørelser tatt i nødsituasjoner. Dette skal oppnås blant annet igjennom utviklingen av mobile apparater som er designet slik at det tilbyr nødpersonell den informasjonen, og de funksjonene de har behov for på en så rask og enkel måte som mulig. Prosjektet ble startet i 2009 og varer ut 2012.

Behandling av data

Intervjuene vil bli dokumentert igjennom nedskrevne notater og digitale lydopptak. All tilgang til lydopptak og eventuelle notater fra deltakerene vil begrenses til Erik G. Nilsson og Mads H. Jahren, og vil slettes/destrueres etter at de er ferdig bearbeidet - senest ved prosjektets avslutning. Alle publiseringer vil bli anonymisert.

Overordnet informasjon om kjennetegn ved enkeltpersoner (kjønn, alder, etc.) vil oppbevares i separate dokumenter. Dataene vil ikke kunne spores tilbake til enkeltpersoner. Deltakerene fra EMERGENCY-prosjektet er underlagt taushetsplikt, også etter prosjektets avslutning. Datainnsamlingsaktiviteten er rapportert til Personvernsombudet for forskning, og oppfyller deres krav til konfidensialitet og oppbevaring av data.

Hva samtykket gjelder

I tråd med Personvernombudets anbefaling om behandling av personvernsopplysninger ønsker vi skriftlig samtykke på at du ønsker å delta i intervjuene. Du kan når som helst velge å trekke tilbake dette samtykke uten å oppgi noen grunn ved å kontakte Erik G. Nilsson på epost erik.g.nilsson@sintef.no eller Mads H. Jahren på telefon 45 61 22 70, eller epost madsjahren@gmail.com.

Ved å skrive under på dette skjemaet samtykker du til å ha lest og forstått innholdet av dette arket, at du har fått informasjon om studiens tilknytning til EMERGENCY-prosjektet og at du ønsker å delta i intervjuene.

________________________ ________________________

Sign Sted, Dato

Appendix 2.
- Interview guide from the interview with two paramedics in Oslo, 07.03.2011

Intervju av ambulansepersonell 07.03.11
Intervjuguide

Pr nå, på et skadested utenfor ambulansen, hvordan foregår:

1. organisering på stedet, ambulansepersonellet imellom

2. Kommunikasjon mellom personell og sentral

3. Kommunikasjon personellet imellom

4. informasjonsinnhenting dersom det behøves(medical assistance)

Benytter dere hansker dersom det er kaldt?
Isåfall hva slags? (Tykke/tynne, Hansker/Votter, Skinn/stoff)
Hva er det vanligste arbeidsoppgavene når man beveger seg utenfor ambulansen,
- dersom det finnes noen vanligere arbeidsoppgaver enn andre?

Pr idag; Opplever dere problemer med teknologien som brukes utenfor ambulansen?
Problemer:

Ser dere noen mangler av teknologien som benyttes?

Forslag

Eventuelle kommentarer:

Appendix 3.
- Transcription from the interview with two paramedics in Oslo, 07.03.2011

INTERVJU MED TO MEDARBEIDERE FRA AMBULANSETJENESTEN I OSLO 07.03.2011
FOR SINTEF OG UIO
2 Intervjuere representert med bokstavene E (Erik G. Nilsson) og M (Mads Helno Jahren).
2 intervjuobjekter representert med tallene 1 og 2.

E: Møte med ambulansetjenesten på Ullevål, og vi skriver 7. mars 2011.

1: Jo, sånn som jeg oppfatter det, og det er mye praktiske ting som viser det: Informasjonsbehovet i ambulansetjenesten det har en helt annen karakter enn informasjonsbehovet i Politiet. Politiet baserer seg veldig mye på stemme.., altså de kaller opp sentralen sin og de får mye informasjon over øret. Mens når vi er ute på oppdrag så har vi egentlig sterkt behov for å få vite mer om pasienten enn det vi får ofte. Vi får en veldig kort beskjed på Locusen om hva som er grunnlaget for å sende oss ut, responsen, og littegrann om historikken noen ganger. Andre ganger så kan det hende at vi får masse irrelevant informasjon som egentlig er forstyrrende i den begynnende fasen av et sånt oppdrag. Vi vet jo at AMK sitter på en del historikk på en del pasienter. Det å ha et eller annet verktøy som på en måte kan hente inn den informasjonen det ville vært, syns jeg, veldig hjelpsomt i vårt..., altså da tenker jeg mer i det vanlige virket. Hvis man da i tillegg kunne ha fått det som heter DIPS, er det ikke det det heter a (henvender seg til 2)? Data Informasjons Pasientjournal Systemet?

2: m-m.

1: Det hadde vært helt overvettes bra.

M: DIPS, kalte du det?

1: Er det ikke DIPS det heter a?

E: Det er en av leverandørene... med det er kanskje det dere bruker da?

1: Det er det som brukes inne på sykehuset.

E: Ja men jeg tror det er flere leverandører av... de har jo pasientjournal - DIPS, blant annet. Men jeg tror ikke de er eneleverandør av...

1: Nei sikkert ikke..

E: Men for dere er jo DIPS relevant

2: Ja, eller hva skal jeg si, der hvor den riktige pasientinformasjonen er. For at det er jo ett ganske stort faremoment, føler jeg, i forhold til at det vi får informasjon om av tidligere hendelser fra AMK-sentralen vår- den har ikke alltid blitt justert. Og det vil si det samme som at: Hvis du har sukkersyke, ikke sant - og så blir du bevisstløs på plata, så får jeg melding om overdose.

M: Fordi det er det stedet?

2: Ikke sant! Mest sannsynlig: Ung mann bevisstløs på plata - ja, overdose får jeg beskjed om. Også er det lavt blodsukker!

1: Og da hjelper det ikke at vi finner ut at det er lavt blodsukker, for da kommer neste gang du får lavt blodsukker så er det registrert på vårt system at du har fått en respons tidligere på mistanke om overdose. De sier ikke at det er en overdose, men det er fort gjort å trekke konklusjonen om at du er narkoman.

M: Åja, så orderen blir lagra? Ikke hva som faktisk har skjedd?

1: Ikke ulykken.

2: Det er ikke noe system i tilbakemeldingen.

1: Og da kommer vi over på neste punkt, nemlig det med elektronisk journalsystem for ambulansetjenesten. Det er noe som har vært arbeidet med i mange år, men man har liksom ikke greid å lande på noe.

E: Men gjelder det da bare tilgangen på journalsystemet eller?

1: Nei, at jeg skriver min journal elektronisk på en plate eller på en laptop, og at det blir registrert sentralt, slik at neste gang noen blir sendt ut på den pasienten så kan de hente ut den journalen, eller at de inne på sykehuset så kan de hente ut den journalen på "hvorfor er denne pasienten her"- sier da primærlegen på den posten. Så kan de gå inn og finne ambulansejournalen sammen med resten av journalene.

E: Så hvordan gjør dere det idag da?

1: Vi skriver en epikrise, eller skriver en pasientjournal på papir.

2: I etterkant så blir jo den scannet da, og lagt inn. Men det kan jo da ta minutter og minutter da, ikkesant. Og vi har jo mange.. sant.

1: I den grad den ikke forsvinner på veien. Så det er veldig dårlig kvalitetsystem og når da vi først snakker om tekniske hjelpemidler så hadde jo sånne.. vi snakket om elektroniske pasientjournalsystem og vi har snakket litt om det med tilgang på andre elektroniske journaler. Men vi har jo en ting til. At sykehusene har idag, for å spare penger, innført et sånt taleregistreringsprogramverktøy for legene, så når legene dikterer journal så skrives mye automatisk, så leser man igjennom det etterpå for å spare ressurser på skrivestua. For dem så er jo det et skritt tilbake - for oss hadde det vært et gigantisk skritt frem hvis jeg kunne diktert den journalen. Dette går jo mere på den daglige driften da.

M: Ja, men vi er ute etter hva som er behov

E: ja

1. Ja og dette er det STORE behov for.

2: Hvis vi tar dette opp imot større hendelser, la oss si at.. Ja når vi var på Øvelse Oslo på toget på som ble sprengt på Oslo S, så går jo vi igjennom togsettet og begynner med en triagering.

1: Kalles det.

2: Ikkesant. Hvis jeg kunne på en måte bare hatt en nummerlapp klistra på og så kan jeg si i en eller annen mikrofon, og det vil bli registrert en eller annen plass, ikke sant: Pasient 1 - Død, Pasient 2 - Kritisk, ikkesant?

M: for noe sånt system har dere ikke nå?

2: Ingenting.

1: Alt går på lapper.

2: Vi går rundt med lapper også driver vi å skal rive av, også må noen andre gå og finne etterpå, ikkesant. Sånn at hvis det da kunne.. fra vårt sted kunne kommet rett inn på en eller annen pc, når vi har gått igjennom feks togsettet, så blir det straks regsitrert på en eller annen laptop da, hva skal jeg si, på en eller annen leder, at i togsettet der sånn så er det 14 kritisk skadde og det er 3 døde, 25 "walking wounded" som det gjerne blir kalt. Så vet han at "Ok, her må jeg samle folk til å få ut de 14 fort". ikke sant?

M: Så da ønsker dere å få gjort dette fortsatt med lapper men også at du..?

2: Vi må merke dem, men en sånn klistrelapp: Det her er pasient 1.

M: Ja, og så med tale til sentralen?

2: Ja

M: Eller noe du trykker på?

1: Nei det har vi ikke plass til.

2: Vi må gå og jobbe med henda vet du. Så en eller annen sånn mikrofon-sak som hører - det tror jeg kunne vært fryktelig nyttig.

1: Ja og også om man kunne hatt mulighet for visuell overføring, altså at det hadde vært et kamera på dette settet som kunne ha filma det vi så.

E: Vi å bare kunne ta et bilde være tilstrekkelig?

1: Det som teknisk sett ville vært det smarteste var at tilgangen til datastrøm lå der og at den som da evt vil se dette kan gå inn også sakse ut da feks et situasjonsbilde av en filmstream.

E: Ja det vil kanskje bare være nyttig å se om en pasient beveger seg eller ikke?

1: Ja, men jeg tenker mest kanskje i mottaket. Hvis de allerede hadde fått alle operatørene som hadde hatt sånn... Det er gjerne en eller to som gjør det som kalles triage da. Og han er på en måte framskutt. Så ingen andre går inn i området før han har vært igjennom. En eller to. Kanskje en triagerer og en hjelper, og så begynner man da å kalle inn mannskaper for å få utbæring til samleplass. Og der står det gjerne en som er Leder Samleplass da, ikkesant. Men det kan være at de som er på sykehuset ønsker å få en oversikt over scenario: "hvordan ser dette egentlig ut?", som da skal ta disse pasientene inn i endelig behandling. Hvis de da kunne gått inn på en pc-skjerm og fått over bildene på disse som har sånt utstyr, så kunne de ha fått et relativt tredimensjonalt bilde av hvordan hele situasjonen... Og da vil de få masse informasjon: Feks: Hvor lang tid tar det før disse pasientene begynner å strømme inn? Hvor mange kan vi forvente?

E: Men når en person da går igjennom da et tog som du beskriver her. Hvem er det da som tar beslutningen etterpå om rekkefølgen av hvem av disse som skal reddes?

1: Det er han som triagerer.

E: Ja, ok, så det er ikke.. han rapporterer ikke det til en eller annen fagleder som så tar beslutninger om..

1: Fagleder får bare beskjed om hvor mange som er på vei inn og hvor mange som er prioriterte.

2: Og om hvor mange som må fort ut. Så avhengig av hvor på kroppen også skaden er.

E: Så den som da triagerer gjør også da vurderingen av om vedkommende bør behandles på stedet eller ikke og sånn også da, regner jeg med?

1: Det er om å gjøre å ikke behandle disse på stedet. Det vi gjør er at vi behandler disse 4 B-ene som vi kaller det, altså de som er bleike, og de som er blå, bevisstløse og de som blør. De gjør vi no med. Men det er om å gjøre å gå inn der og gjøre minst mulig for hvis det er 20 stykker som er skada så vil vi sannsynligvis gå til han som skriker mest. Og det som er om å gjøre å gjøre det er å opprettholde liv. For å se til at de kommer ut.

E: De skal ut altså nesten uansett?

1: Alle skal ut!

2: De som kan ut, de jager du ut, de som er død - de lar du ligge.

1: Triagererens oppgave det er å legge folk i stabilt sideleie, heve beina til dem, få noen til å putte en finger i et sår, holde frie luftveier, sånne ting. I det du setter deg ned og begynner å gjøre innovasiv behandling på en pasient så er det 19 andre som kan dø. Og det er jo det som er vanskelige valg..

E: Ja, det var ikke det jeg tenkte på, jeg tenkte mere på at kanskje noen da skulle få annen type behandling hvis det er brudd på hjerneskallen og sånne ting hvor pasienten kanskje bør behandles uten å flyttes.

2: Du kan si det sånn: En sak som vi har snakket om nå hvor man kan rapportere inn til en pc: Der kan det da være en fagleder som vil si det at pasient nr 3...

1: En fagleder er en lege.

2: .. en lege, pasient nr 3 og 7 - glem det, han har hodeskader, han får vi ikke redda. fokuser på de...

E: Men han vil også kunne ha no bruk for bilder eller...

2: Ja, så hvis det kunne ha kommet opp..

E: For dere er ambulansepersonell?

1: Ja vi er paramedics.

E: Og dere er Ikke leger?

1: Vi er ikke leger.

E: Men er det en egen utdanning eller er det en form for.

1: Egen høyskoleutdanning.

2: Når det gjelder masseskader så er det vanlig å dele de på en måte inn i to typer: Du kan si at det er type 1, det er at du har såpass mye ressurser at du kan få evakuert alle pasientene med en gang til sykehus. Type 2 kan du si at da har du ikke nok ressurser til å få dratt av gårde med alle med en gang, så da må man etablere en samleplass hvor man skal starte behandling. Dette systemet vi har snakket om nå det vil kunne avgjøre veldig raskt om vi er i en type 1 eller type 2 situasjon.

E: Det kan den som triagerer avgjøre da eller?

1: La meg konkretisere et par ting nå til båndspillern blant annet. Det ene er det at det er ikke uvanlig at den som gjør triage er lege. Det kommer litt an på ressurser. Og da kommer jeg over på det som er årsaken til at man må skille mellom type 1 og type 2 hendelser. Det er jo ikke minst hva slags ressurser man har tilgjengelig. En stor trafikkulykke på Skreia kan være en katastrofe i den grad at det er 1 sykebil der, og det er 8 skadde. Mens.. jeg husker den første masseskaden jeg var på, det var på midtstuenulykken i 87. Den trikken som gikk.. Det var vel kanskje litt før du ble født eller et eller annet sånt (Ler henvisende mot M)?

M: Året etter.

E: Har en vag erindring.

1: Ja. Så vi har holdt på en stund! Da husker jeg at da var vi så heldig at det skjedde akkurat klokka 3 og da var det full avtroppende og full påtroppende samtidig, så da hadde vi nok av biler, og da hadde vi nok ressurser der oppe til å ta de ut fortløpende. Det vil si at da dro de folk ut fra vraket og vi kjørte de bare av gårde med en gang. Så vi slapp å måtte opprette samleplass. Samleplass opprettes først og fremst der hvor ressursene ikke er tilstrekkelig i forhold til behovene. Og det er klart det at, på en samle plass der det er mørkt og der det er kaldt er det ikke noe trivlig sted å være. Og ihvertfall ikke hvis du er dårlig! Så det gjør vi jo veldig nødig da. Vi ønsker jo ikke å behandle disse pasientene. Og uansett - de aller aller fleste trenger kirurgisk intervesjon og det har vi ikke muligheter til å tilby utenfor sykehus.

E: Og kirurgisk intervesjon da snakker vi om sying og..

1: Da må man åpne og..

2: Det eneste, hva skal man si, som kan være nyttig er amputasjoner, ikkesant fordi folk sitter fast.

1: Ja. Men den kirurgiske intervesjonen den har vi leger som gjør.

E: Hvem er det som tar den avgjørelsen: Dette er en ener eller toer type hendelser...

2: Det blir vel et samarbeid.. altså hvis (henviser til 1) er inne i toget, jeg er en leder utenfor, også skaffer jeg inn informasjon om hvor mange sykebiler har jeg og sånne ting, også melder han ut antall skadde, og kategoriene. Så må jo (henviser til 1) og jeg sammen avgjøre om dette er en type 1 eller type 2-hendelse.

1: Sånn som vi opererer idag så er det jo sånn at AMK skalerer jo allerede utifra de meldingene som blir gitt da. Da sender jo AMK ut.. altså Akutt Medisinsk Kommunikasjonssentral, 113-telefonsentralen, de sender jo ut ressurser i henhold til hva det kan høres ut at det er behov for, og gjerne litt i overkant hvis det fins ressurser. Og de har lav terskel for å sende ut leder. En som har definert oppgave som leder.

E: Er det da han du omtalte som fagleder?

1: Ja, det er det vi kaller for operativ leder i helse. Fagleder helse det er lege, operativ leder i helse det er da en av oss. (henviser til seg selv og 2). Så vi har en matrise ledelse på det skadestedet, hvor operativ leder helse sørger for alt som har med ressurser og sånne ting å gjøre, og legen pleier ofte å bli stående på samleplass, og gjøre nødvendig luftveistiltak bare for å opprettholde de ytterligere til vi får de på sykehus. Har dere fått et bilde av hvordan det...

E: Ja litt av det. Jeg var feks til stede på den TYR-øvelsen, ikke nå i høst men forrige høsten, da det var nede på Herøya.

1: Åja, ja.

E: Den nasjonale... Det er Politiet som arragerer den da, men der var jo alle blålys-etatene og pluss pluss til stedet. Og der var fagleder helse stort sett.. stod sammen med politiet og fagleder på brann da.

1: Hos oss kaller vi han Operativ Leder Helse. Vi har en som er egen Operativ Leder Helse. Vi er såpass stort distrikt at Fagleder Helse har ikke noe særlig operativ erfaring. Det er en lege som har lege-kompetanse. Så derfor har vi funnet det nødvendig at vi må ha en Operativ Leder Helse. Jeg trodde at de fleste distriktene hadde det nå egentlig jeg? (Spør til 2) Bergen har ihvertfall?

2: Ja

E: Det er mulig at jeg husker feil. Jeg husker hvertfall at det stod Fagleder Brann på ryggen..

2: Neida altså det er jo en leder.. I større ting så er det jo en lederfigur fra de 3 etatene som da skal...

1: De går gjerne i KO, som det heter.

E: Ja for det var der jeg befant meg stort sett på den øvelsen. I det lokale KOet.

1: Og i det KOet så er det klart at med et kamera og en form for voice-recorder som evetuelt kanskje registrerer direkte hva du sier. At: "En skade-prioritet: Rød", ikke sant, som er da de som må ut - fort!

M: For dere har fargekode på det?

1: Ja, gul, rød og grønn, også har vi noe som heter svart - som er...

2: Det sier seg jo selv.

1: ja.. død.

E: Så du kan si at dere deler det i 4 kategorier altså?

1: Ja, også fungerer det sånn at vi har sånne lapper som henger rundt halsen, så kan du rive av sånne striper da. Ikkesant, så er da svart den øverste da, også er det rødt, også er det gult, også er det grønt. Så hvis du i utgangspunktet er frisk så river du ikke av noen lapper- da er du grønn. Men så blir du litt "tufs" etterhvert ikkesant, så kan du ta bort den lappen. Men vi kan aldri sette den på igjen, ikkesant.. Så blir du opp-prioritert, så kan vi ikke prioritere deg ned igjen.

2: Så det er på en måte grunn-tanken. Men så er det noen som har en sånn, hva skal jeg si, enda mer- kall det rask sak som egentlig nesten går på rød/grønn bare - umiddelbart.

1: Rød/gul ofte..

2: Ikkesant, sånn at ikke du..

1: Førstepri... For å finne ut, ikkesant: "Hvor dårlig er du?". "Ja du er kjempedårlig!" eller "du er ikke fullt så dårlig." Også ikke noe mere tid-bruk på det da liksom.

2: Du kan ligge der en time liksom, ikkesant..

E: Grunnen til at jeg spør om det... Dere snakker her om å diktere inn noe, også snakket vi om.. eller (henviser til M) spurte her om det var liksom mulighet til å kunne ha med seg noe apparat rundt. Men går det an å tenke seg noe midt imellom? Når kategoriene er så få da, feks å ha noe strippet rundt armen med disse 4 fargene på, så trykker du på en knapp på det, så blir det registrert sammen med pasientnummeret eller noe sånt noe? Sånn som vi forsker så kan man bare dikte at det finnes. Så hvordan kan noe sånt utformes?

1: Det vi bruker idag det er: Du vet sånn som ungene har, sånn refleksbånd rundt, sånn som du bare klikker rundt. Det bruker vi idag for å gi første....

E: Nå tenkte jeg at det var noe dere skulle ha på dere, jeg, som var en elektronisk ting som dere...

2: Åja, og så var det sånn? (ukjent hva her henvises til)

E: Ja, og så trykker du på.. Så ser du at her har vi en rød en: Da trykker vi rødt her sånn. Også at man feks hadde hatt noe posisjonering eller en eller annen mekanisme for å koble det til hvilken pasient det er. Med det kan man også oppnå med noe RFID, eller noe sånt noe da. At du istedenfor for å koble en klistrelapp på han, så klistrer du på en elektronisk dings. Også når du da trykker på den så kommuniserer de seg imellom også er den informasjonen...

1: Det er klart at hvis vi kunne gjøre dette med stemmen, så hadde det vært det aller beste. Jeg tenker feks at vi hadde hatt sånne lett gjenkjennbare begreper som feks: "Pasient". Det er jeg sikker på at det er ganske lett for et sånt system å registrere, uansett hvem som sier det. Og så et nummer: "En". Og så: "Rød". De tre tingene er jeg ganske sikker på at du vil få en høy kvalitetssikring på.

M: Hvis du har få ord så er jo det...

E: Det er jo det disse journalsystemene også er basert på da. At vokabulæret er begrenset.

1: Ja, og at det ikke blir mye dialekt da, og mye.. ja hva skal jeg si, fremmeddialekt...

E: Også har du selvfølgelig støy, støyproblematikk oppi det her også da.

1: Det er et stort problem! For det er veldig mye støy på et sånt sted vanligvis.

2: Men tilbake til den, hva skal jeg si, elektroniske dingsen. Hvis vi skal dikte opp noe da. Hvis jeg hadde hatt en eller annen merkesak som jeg da.. Hvis han hadde vært skadd, så dytter jeg den på den, ikkesant.. og rød, ikkesant. Så går jeg videre. Og så begynner den saken å registrere feks kroppstemperatur!

1: Ikke kroppstemperatur (henviser til 2), perifere hudtemperaturer betyr ingenting..

2: Neida, men registrere noen parametere.

1: Kunne ha lytta på pasienten feks, hørt om han pusta.

2: Nei altså jeg bare tenker sånn at da blir det en form for elektronisk overvåkning: "OK, nå er han iferd med å... ". Ikkesant? Om det da blir hjerteslag, eller pusting eller temperatur eller..

1: Kunne satt den på halsen på han så kunne man hørt om han pusta, for du hører jo skrapinga på ventilasjonen hvis du hadde satt den der. Det skal ikke så veldig god mikrofon til for at du hører hvertfall at han puster, kremter og lager lyder.

E: Nei, vi har kolleger som jobber med sånn type teknologi, så det kunne også ha vært en interessant kobling. Og de har blant annet sett på det. Men det har vært på brannfolk da. For å monitorere deres helsetilstand. Men da kan de montere sånn pulsbelte på brystet og sånn, men det vil være litt mer upraktisk for dere da vil jeg tro.

1: Det tar litt tid.

E: Og den tiden har dere vel ikke..

2: Så da måtte det på en måte blitt en eller annen sånn klistresak som..

M: Hvis dere har et litt sånn større "refleksbånd" som du tar rundt armen, så kan du vel få den, jeg vet ikke, rundt nakken eller noe sånt noe?

1: Det som fins av teknologi nå.. Jeg vet ikke om dere kjenner til pulsoksymetri-teknologien? Altså det settes en probe på en finger som da lyser igjennom med en viss fargeskala, som da har en mottaker som da registrerer om blodet er mettet eller umettet. Altså om de rød blodlegmene er mettet.

E: Kollegene mine hadde et foredrag hvor de.. jeg tror det var en sånn en som de sendte rundt, hvor de hadde koblet til en mobil som du bare kunne sette på fingern, også ser du pulsen..

1: Ja de er så små de nå at du...

M: Hva var det de het for noe?

1: Pulsoksymetri.

2: SPO_2 kan du bare skrive.

1: Den måler altså blodets saturasjon da. Sånn helt på "nynorsk".

E: Nei, for jeg lurte på åssen den virka. Bare stikke fingeren inn i der..

1: Ja. Men nå fins det utstyr som også regsitrerer mer enn om bare blodet er mettet eller umettet, men også til en viss grad hva det er mettet med. Altså om det er Karbonmonoksid(CO), om det er oksygen og man ser også hva slags mengder av cyanider som fins i blodet og sånn. Så det er blitt ganske god teknologi. Det som kommer nå, som jeg vet at de driver og forsker på borte i Seattle, det er at de har... som vi har vært med på forskningsprosjekt.. at de har muligheten til å gjøre denne registreringen, ikke ved gjennomlysning, men ved refleks, slik at du kan feste den mye mer sentralt. Altså fingeren din er jo det første stedet som ikke blir gjennomblødd når du begynner å bli tufs. Og da mister du verdiene. Og da er det klart at hvis du ikke ser pasienten da, så vil du da hvis du sitter på en sånn skjerm, også har du 10 pasienter med parametere på hvor det er kanskje ett av få parametere, så vil plutselig han forsvinne. Da er han død. Det er ikke sikkert han er død, det kan hende han har blitt litt kald på hendene. Nå fins det utstyr som du kan sette mye mer sentralt, feks i panna. Det er sånn at kroppen har et sånt auto-reguleringssystem, hvor blodet kan skjemtes unna fra de mindre viktige stedene, og liksom hodet er jo alltid viktig, inklusivt huden. Derfor så har du stort varmetap igjennom hodet, og man bruker lue og skjerf, nettopp fordi herfra og opp(peker på halsen og opp) så regulerer ikke kroppen etter seg. Dvs der vil du ha gjennomblødning av huden, også når du blir ordentlig tufs. Vi prøvde ut noe utstyr, det så ut som en liten femmer på en måte, som satt fast på et sånt bånd som vi bare satte rundt hodet på pasienter som hadde hjertestans. Og så klemte vi på brystet dems, også så vi om vi kunne få registrert den lille sirkulasjonen vi gjør når vi klemmer på brystet til pasientene. Dette her er helt innovativt, men det er klart at en sånn.. altså en teipbit med sånn som du bare setter på panna til pasienten..

M: Ja eller sånn strikk.

1: Eller strikk ja. Det ville vært smart. Altså hvis den hadde hatt mikrofon som hadde hørt at pasienten pusta samtidig, så begynner vi å snakke her!

2: Litt tilbake til disse type 1/type 2 hendelsene..

1: Er det riktig å bruke de begrepene?

2: Altså det er bare noe jeg fant opp nå da.

1: Ja det er det viktig at dere registrerer. Det vi kan kalle, for å ha noe gjenkjennbart for type 1 og type 2 så er det da er om det er en masseskadesituasjon som overskrider ressursene eller ikke.

M: Ok.

2: Altså, en type 2 - da må du begynne å samle pasienter på et sted, fordi du får ikke fraktet de videre direkte til sykehus.

1: Et sted hvor du har oversikt og hvor du har ressurser til å kunne behandle dem der og da. Og da snakker vi om Livsforlengende behandling, og ikke endelig terapeutisk behandling.

2: Opp imot da den informasjonen som vi da på en eller annen måte da raskt kan formidle inn til en eller annen pc. Feks da fra togvogna. Og hvis man da samtidig kan linke dette her opp imot hvilket sykehus pasient skal til. Ikkesant at man går inn: "Der er det ledig plass for den type skader, der er det den.."- ikkesant? Og da går det liksom bare an å.. booker du den plassen også får da de som skal transportere pasienten videre bare beksjed om at det er booka plass på rikshospitalet.

E: Dette er en Oslo-ting man kan gjøre sånn? Det er ikke sånn andre steder i Norge at man kan velge sykehus?

1: Nei. Nei. Men det er ikke bare fordel med det, bare så det er sagt!

2: Det kan være kanskje enda viktigere hvis du står midt i østerdalen, ikkesant, også har du St.Olav, også har du Elverum, eller du har Tynset sykehus, ikksant? Hvor har de plass? Jeg må vite det raskt!

1: Når jeg dit, og har de noe å tilby pasienten? Ikkeminst, ikksant? Altså Tynset Sykehus, der gjør de ikke stor thorax-kirurgi, altså stor bryst-kirurgi, det er helt sikkert, så man kan ikke kjøre pasient dit, bare for at det er en plass der!

2: Og da samtidig få sendt av gårde de viktige pasientinformasjonen på vitalia til det sykehuset, så kan man da drøfte med kirurgen på St.Olav feks da; Om det er noe vits i å dra dit.

1: Det blir litt mer KO-arbeid da, det er ikke triagen som bestemmer det, men altså..

E: Det er typisk KO som vil gjøre den..

1: Ja KO, eller lokal.. eller LRS da. Altså det kan hende at veldig mange av disse dataene, hvis man hadde fått de "Hubba" inn mot en LRS-sentral som sitter og ser, ikkesant, etterhvert som vi begynner å registrere pasienter, så popper de opp som sånne små vinduer, "Thumbnails" på storskjermen. Ikkesant, så kan de se hva vi ser, så kan de se og høre feks parameterene, feks om pasienten puster eller ikke, osv, også hvilken kategori de har. Så kan de sitte og ha en hel stripe med pasienter, og følge med på hver enkelt. Også henter de bare ned og sier at "denne går til Rikshospitalet, denne går til Ullevål, 3 på Ullevål, også vet vi at flere skal til Ullevål etterhvert som vi får tømt, så det kan hende at de sier at vi må holde igjen de pasientene der". Ser dere for dere det bildet jeg ser for meg nå?

M: Ja.

E: Jada.

1: Du får opp hele scenarioet med kart, også har du da etterhvert alle pasientene som popper opp som thumbnails, også har du alle ressursene etterhvert som de popper opp som thumbnails. Det hadde vært et kjempesnedig greie.

M: Ja. For da kan du også, hvis du kobler opp til noe GPS, eller noe lignende da, så kan du også ha et kart over akkurat hvor de ligger og..

1: Ja. Det er nok ikke interessant. Det som er mer interessant der er vei inn-vei ut, oppmarssted, noe vi kaller for ambulanse-kontrollpunkt, altså det vi kjører ut, ikkesant. For husk på det: At det er veldig fort å forregne seg i dette arbeidet. Du sender ut 10 sykebiler, det er 20 mann, ikkesant? Noen skal bemanne samleplass, noen skal drive med innbæring, noen skal gjøre triage: Hvem skal kjøre sykebilene? Og hvordan ender jeg opp med makkeren min oppe i dette her? Ikkesant, du ser jo det står jo 10 sykebiler der, ikkesant. Hvorfor er det bare 2 på vei? Hvorfor begynner de ikke å kjøre ut pasienter? Og det er jo fordi de holder på med andre ting der ute. De kjører ikke ut med ekstra ressurser, eller ekstra mannskaper som kan bli på skadestedet.

M: Men er det en ide å ha noen funksjon for det, sånn hvis man kom til et større sted..

1: Ja, det som hadde vært en ide hadde vært at man blir på en måte, hva skal jeg si, låst opp.. i det øyeblikket jeg er låst opp, feks med å være triage, så vet de at "Den bilen der, den kan ikke kjøre derifra", før det stigmaet jeg har fått som triager er tatt av meg. Når jeg har triagert alle, og alle pasienter er bært ut av skadestedet, da er jeg fri for oppgaver, da må jeg få en ny oppgave. Kanskje jeg skal kjøre pasienter, kanskje jeg skal fortsette inne på samleplass å behandle pasienter - Sånn at man hele tiden ser: Hva er det man har av transportressurser. Det er jo ofte sånn at.. Det som er faren er at man fryser fast på skadestedet, med å fordele så mange oppgaver at det er egentlig ingen som kan begynne å transportere pasientene, og det er logistikk vi driver med. Så det er en relativt, hva skal jeg si, komplisert logistisk oppgave, det å se: Hva er det vi egenlig har av.. altså hvordan greier vi å få turnover her nå? Har vi noen som kan kjøre disse pasientene, eller blir de bare der og får mer og mer væske og blir kaldere og kaldere?

2: Det er viktig det.. altså vi hadde jo en øvelse nede ved havnelageret for noen år siden.

1: Bare et steinkast unna der hvor den godsvogna gikk ut!

2: Ja, ikkesant! Og da var jeg en observatør som skulle registrere dette ambulanse-kontrollpunkt, altså når drar bilene ut?

1: En som står og registrerer: Bilen stopper..

2: Fra øvelsen skjedde, til første pasient ble transportert ut så tok det 1 time og 37 minutter!

1: Da er det mange som har blødd seg ihjel altså!

2: Ikkesant, nettopp fordi det var på en måte ingen til å kjøre sykebiler, fordi alle måtte jobbe inne.

1: Du vasser rundt i vrakdeler, ikkesant, og du skal prøve å få disse pasientene ut. Noen ligger fastklemt. Du kan si det ligger en som er fastklemt. Han er alvorlig skadet men stabil. Så er det sånn at jeg som er triage, jeg må gjøre den tunge jobben med å skritte over han og si at du må nok ligge her med det fastklemte beinet ditt en stund til. Men så kommer det noen dit, på et eller annet tidspunkt. Enten fordi de hører han skrike, eller at de har fått ordre om å gå dit. Og det også er veldig vanskelig: Det er å la være å gå dit man ikke har fått ordre om. Ikkesant: Han som ligger der, han skal ut. Også går du forbi en som ligger og skriker, også stopper du opp. Og så går tiden. Han blør (Henviser til han han har fått ordre om å gå til). Han blør ikke så mye(Henviser til den fastklemte) men har det veldig vondt. Han blør (Ordreobjektet), og hvis vi ikke får stoppet den blødningen så dør han. Og på den måten så går tiden, hele tiden. Og på et eller annet tidspunkt så må to mann bort til han, for å hjelpe han, sammen med brannvesenet. Og gi han smertestillende, sørge for at han har det bra når de løfter av den store betongklumpen som ligger oppå beinet hans, for å si det sånn. Og det er også ressurskrevende. Og det å hele tiden ha en oversikt over hvilke oppgaver er det det mannskapet gjør nå, og hvor lang tid vil det ta? Og det at man da raskt kan fristille seg, det øyeblikket jeg er ferdig med å gjøre triagen min, så fristiller jeg meg: tar av meg den hatten. Sånn at de som sitter inne ser at: Der tok han av seg den hatten ja, da er den fasen over.

E: Men hvem er det som bestemmer dette her? Er det Operativ leder som..

1: Operativ Leder Helse som bestemmer dette.

E: Ja. Er det også vedkommende som sier hvem som er triage og.. Eller er det førstemann som kommer til stedet?

2: Det er som regel første enhet som kommer på stedet som starter med det, for å kunne begynne å gi tilbakemeldinger. Det er sånn viktig ting å spesielt tenke på, med film, fotografier og sånne ting. Når slike ting skjer så er det mange som blir fryktelig nysgjerrig.

1: Det må være skjerma ja.

2: Ikkesant. Og også, hva skal jeg si, fra våre rekker! Det er et begrep som vi kaller åstedsturisme. Plutselig så er det fryktelig...

E: De vil jo få masse nytt og morsomt å se på!

2: Ja, nettopp!

1: Norsk forening for Skuelystne! (henviser til en sketch fra team antonsen eller noe sånt)

M: Ja, den er bra!

2: Og plutselig så er det fryktelig mange, feks i fra administrativ ledelse som bare vil se! Og det kan jo stjele en del kapasitet, på en eller annen måte.

1: Man må ihvertfall ta høyde for at ofte så kan det være lurt å styre den informasjonen som kommer inn til alle, altså det er noe som heter "need to know basis"-ikkesant? Og des mer du vet, des mer grunnlag har du for å ta beslutning, og oftere des langsommere skjer beslutningsprosessen da. Og vi har mange eksempler på det at... Det gjelder forsåvidt i vanlige situasjoner det, at hvis du vet for mye om et medikament så vil du kanskje slutte med å gi det, fordi det kan hende at pasienten får motsatt effekt også har du..

E: Du må jo ikke lese om bivirkninger, da er du garantert å få de, ihvertfall sånn er jeg!

1: Ja.

E: Men dette med.. Når triagen har vært, og merket. Hvordan.. Er det liksom store tall? Er det det som.. må være et visst nummereringssystemg gjennom et skadested? Hvordan finner de som da kommer som bølge nr to tilbake til disse pasientene som er prioritert?

1: Jo når du da har fått et tall, du er pasient og du har fått et tall, eller du har fått en farge da kan du si. Du har fått et tall, som er deg, også har du fått en farge. Du heter ikke (henviser til E), men du heter 4.

E: Ja.

1: Også har du fått en fargekode som forteller hvor dårlig nummer 4 er. Så vil triage rapportere tilbake: Vi har 8 pasienter kategori rød, og vi begynner med han som ligger sør-vest i skadestedet. Og så peker du sånn: Han først, så han, så han, og så han.

E: Så du gjør det visuelt altså?

1: Ja.

E: Og hvis du er i en.. hvis vi tar dette togeksempelet da. Så vil du si hvilken vogn det er og hvor i vogna og sånn, gi en muntlig beskrivelse altså?

1: Ja, og hvor de er hen.

2: Det er sånn det foregår pr idag, eller vil foregå pr idag. Men å ha en eller annen sånn GPS-sak med halsbånd det er jo.. Kan sikkert være spennende nok det, hvis det går an å..

E: Det har vært gjort en del arbeid rundt sånn tagging av pasienter, det vet jeg altså. Men jeg har ikke helt.. Men det kunne jo du (Henviser til M) evt tittet på hvis vi bestemmer oss for å følge akkurat den biten da. Og der har det vært brukt masse forskjellig teknologi med blutooth og RFID, og ulike radiosendere med ulik rekkevidde da. På GPS vil det jo som regel ikke fungere godt inne i et vrak av noe slag da.

1: Og hvertfall ikke inne i tunell feks.

E: Ja, men det er masse andre teknologier som kan benyttes, og du kan benytte signalstyrke her for å avgjøre avstander og..

1: Og det er veldig viktig å ta høyde for dette med båndbredder og sånne ting, for det er et stort problem. Kanskje ikke først og fremst for oss, men særlig for brannvesenet at VHF som vi bruker på vårt samband er ikke noe veldig godt egnet hjelpemiddel nede i kjellere og.. Og ikkesant, røykdykkere i brannvesenet.. Nå har vi fått et nytt nødnett, det har dere sikkert fått med dere, eler vi er i ferd med å få det implementert. Helsevesenet ligger etter fordi vi har et mye mer komplisert og mangfoldig behov. Mens jeg vet at i brannvesenet så opererer de fortsatt med egne walkie-talkier for røykdykkerene sine feks. Fordi det er ikke alltid det er like god dekning.

2: Det er dårlig dekning inne i hus.

M: Generelt, alltid?

2: Ja.

1: Inne i hus, og nede i kjellere, og ikkesant når du skal sende ned røykdykkere så er det alltid greit at du veit..

E: Men de går da på bedre frekvenser?

1: De går på UHF. Det går igjennom...

M: Men dere har bare VHF?

1: Vi har bare VHF. Men det er vel mulighet for å sette disse over på UHF, men jeg er ikke noen spesialist i det nye nødnettet.

E: Nei, sånn som jeg har forstått disse her.. med det å snakke med folk i brannvesenet så er det jo også.. det er folk som har både to og tre radioer det her da. Også fordi de skal være et bindeledd så får du du får liksom.. Den kontinuerlige kommunikasjonen mellom en røykdykker og en røykdykkeleder den ønsker du ikke skal spres utenfor akkurat det lille laget da.

1: Nei, men det er ikke bare det. Det er også det at det er teknologiske utfordringer her.

E: Ja det er det sikkert.

1: Og det er klart at det burde jo være unødvendig egentlig; at vi opererer med fryktelig mange forskjellige alternative sambandsmuligheter.

(Litt tomt snakk, urelevant for forskning)

1: Hvis du nedskalerer dette her fra en større hendelse til en mindre hendelse, så er det sånn at hvis teknologien først hadde vært der, så ser jeg helt klart nytten av å kunne feks overføre bilder til traumeteamet.

E: Traumeteam er de på sykehuset.

1: Ja, når vi er ute på en trafikkulykke så er det en eller to hardt skadde, eller noe sånt noe, også varsler vi traumeteamet, så traumeteamet blir scrambla. Så har de muligheten til å gå inn og se på en pc-skjerm også ser de bildene fra hjelmen min, eller fra headsetet mitt eller et eller annet sånn. Så de kan snakke med meg også. Så, ikkesant, det blir jo i og forseg det samme..

E: Men er det den dere har idag?

2: Nei.

E: Nei, det er noe for ettertida ja?

1: Ja

2: Slik de har løst det på andre steder i verden.. Feks da AMK-sentralen.. På en av lederbilene som kommer frem, så blir det satt opp et eget kamera, som blir styrt fra AMK-sentralen.

1: I Israel så har de en egen..

M: Som er på montert på bilen?

2: På bilen.

1: Ja, den står.. også kjører de bare opp en stor stang, en sånn teleskopstang, også på toppen der så står det et kamera, også sitter AMK med joy-stick også bare sveiper de over området.

2: Og da kan de videreføre de bildene til sykehus og..

E: Men der vil du ikke kunne se.. Hente detaljer om skadede..

1: Nei, nettopp, men du kan tenke deg da hvis du har et sånt bilde da, som du da har delt i to igjen, hvor kartet er på den ene siden, også har du da "oversight" med et stort kamera. Også får du etterhvert opp bildene på de som gjør triage, og eventuelt også parameterene på det, ikkesant? På den enkelte pasient. Også kan du trekke det bare ned i en boks som heter samleplass etterhvert som de flyttes. Så kan de som sitter inne i lokal redningsgruppe.. Så kan de bare se at nå begynner de å tømme.. De ser at det kanskje er kork på.. altså ut av samleplass. At de ser at det går fler og fler pasienter inn på samleplass, men at det går få ut av samleplass, så kan de gripe inn tidlig og si til Operativ Leder at "nå må du omfordele ressursene dine, for nå må vi begynne å få pasienter ut ifra samleplass. Da ville du fått en fryktelig fin oversikt over det altså! Også sett på ressursene under, samtidig. Nå fikk jeg nesten lyst til å tegne sånn.. hvordan jeg ville ha sitti her i dette rommet her også gitt beskjeder.

E: Men akkurat det med sånn bilde og videooverføring så har vi en sånn gruppe med internasjonale forskere som.. Vi møtes en gang i året. Det er flere prosjekter som gjør det da, men en av de som sitter i den gruppa er en som har tatt en dr.grad i Gøteborg..

1: Svenskene er flinke på dette her!

E: Ja, en som heter Jonas Landgren. Og han gjorde en sånn veldig empirisk dr.grad, hvor han hadde 200 timer på ambulanser og brannbiler og.. Han samla masse empiri da, men han.. Det han endte opp med å gjøre der var å primært se på det ene bildeoverføring. Og der kan det hende at det også kan være en kommersiell løsning som er kommet ut av det.

1: Jeg vet at de prøver ting i England. Med hjelmkameraer på IMS-personell..

E: Her tror jeg de brukte, rett og slett mobilkamera. At de gjorde dette via mobiltelefon.

1: Men da får du en hånd mindre!

E: Jada.

1: Men jeg ser det at, for mitt vedkommende så ville et headset vært nyttig i veldig mange sammenhenger. Jo, det er en annen ting som også.. Hvis vi snakker om teknologiske utfordringer og løsninger, det er kommunikasjon i sykebilen. Når jeg sitter og kjører så kjører jeg gjerne med folk som har lavere kompetanse enn meg selv, og de skal jo også lære, og sånn sett så er det jo viktig at de også får "hands on" erfaring med pasientene. Jeg kan ikke gå og sette meg bak sammen med alle pasientene bare fordi jeg er best! For da blir de aldri bra!

M: Neinei.

1: Men så er det jo sånn at jeg samtidig ønsker å ha kontroll på hva som skjer bak i bilen. Så da: Opp med luka og begynne å hyle: "Hvordan er blodtrykket nå?" og.. ikkesant? Det er veldig støyete og forstyrrende, også.. En intercom i sykebilen. Og den intercomen behøver ikke å være festet til sykebilen, men det kan være mulig for meg å switche over til intercom med makkeren min. Feks via blåtann. Så hvis du da har et sånt, kall det sånn multifunksjonsapparat som du setter på hodet ditt, med kamera og med en øreklokke og microfon. Og hvis det er et problem så fins det jo mikrofoner som ikke tar opp omgivelsesstøy som bare ligger på strupen feks, eller midt oppå hodet.. Brannvesenet har jo sånn greie som ligger inne i hjelmen sånn bare rett oppå hodet.

E: Fins også inne i øret er det noe som..

1: Ja. Jeg ser bare for meg et kamera på størrelse med den som sitter her. (Plukker opp mikrofonen til opptakeren. Ca 2cm lang og på tykkelse med en penn.)

E: Det de gjør der er at de tar opp stemmen.. At først filtrerer de støyen igjennom den ørepluggen og istedenfor å ta opp stemmen utenifra, så tar de opp stemmen inne i hodet. For da sitter mikrofonen inne i øret. Så det de andre hører er den samme stemmen som egentlig personen hører seg selv da, så sånn du tror snakker er faktisk sånn de andre hører deg!

2: Hva med de andre stemmene jeg har inne i hodet da?

E: De tror jeg ikke kommer med! Men det er ganske dyr teknologi enda da. Det er markedsført da særlig imot forsvaret tror jeg. Som da kan sitte også føre en normal samtale inne i en tanks og sånt da.

1: Ja, men brannvesenet bruker jo da mikrofoner som sitter midt oppå hodet, som gjør vel antageligvis akkurat det samme men teknologien er sikkert mye billigere og større og sånn..

E: Ja, men da er det også basert på at hjelmen tar en del støy da tenker jeg?

1: Ja den ligger som en sånn, nesten som en sånn sugekopp midt oppå hodet dems.

E: Men dere bruker aldri noe hjelm eller noe sånt noe?

1: Jo vi bruker hjelm, ihvertfall i disse situasjonene.

E: Men ikke alltid?

1: Nei, desverre. Vi skulle brukt det mye oftere. Det er jo et sikkerhets og teknisk.. eller sånn kulturelt..

E: Nei men hvis dere alltid hadde brukt hjelm så hadde det vært et naturlig sted å plassere en sånn mikrofon.

1: Jeg sitter ikke inne i sykebilen med hjelm på hodet uansett!

E: Nei, det gjør de vel kanskje bare i Sverige det!

1: Gjør de det?

E: Nei, jeg bare tuller!

1: Men det skulle ikke ha overrasket meg!

E: Men det er jo en typisk stereotyp

1: Stereotype svensker ja!

2: Det er hvertfall viktig at den informasjonen som på en måte kommer, eller gis og mottas, den må på en måte være hørbart, ikke noe sånn skriftlig sak. Noe meldinger og den type ting.

1: Men det som vi sier, hvis det kunne ha gått rett inn på en sånn.. La oss si tre bokser da: Pasient, kode...

2: Ja, altså fordi vi er opptatt med andre ting Nesten daglig så opplever jeg det i ambulansen: Vi får et oppdrag kode gul.

1: Hasteoppdrag.

2: Hasteoppdrag. Også samles det mer informasjon også blir den oppgradert. Men så får jeg ikke beskjed om det, men det kommer på skjermen! Men jeg kan ikke drive og titte på skjermen, jeg må kjøre bil!

M: Skjermen i bilen?

2: Skjermen i bilen.

E: Men når dere er på vei ut så sitter vel makkeren din ved siden av.

2: Jo, men da driver han eventuelt og skriver journal, eller veiviser.. Jeg har kanskje skjermen over på kartverket, og må trykke på en annen knapp for å få frem informasjonen.

M: Men hva hvis du hadde hatt feks en skjerm her da (Peker på nedre del av armen) hvor du...

1: Det hjelper ikke, er i veien når du kjører bil.

E: Jeg tror det er lyd når du kjører bil.

2: Ja..

1: Men det er et kulturelt spørsmål (henviser til 2).

2: Jo men jeg tenker sånn at mye av alarmer, forandringer som piloter har, så er det en lyd som gjør de oppmerksomme på at det er et eller annet.

M: Jo, og så ser de på skjermen?

2: Feks.

M: Ikkesant, så dere kunne jo hatt noe av det samme, at dere kunne fått en lyd..

E: Men nå er vi litt over i LOCUS-land her da! Men vi har jobbet med dem tidligere, vi gjorde en evaluering av en tidlig versjon av det nye systemet deres og der husker jeg at vi var inne på litt den type problemstillinger og. Og blant annet også å få denne fargekoden synlig hele tiden, feks at den alltid er tilstede på skjermbildet.

1: LOCUSen har blitt veldig mye bedre enn det den var i starten. Og jeg vil si at jeg i all hovedsak er fornøyd med det hjelpemiddelet. Men det har litt med sånne kulturelle ting og egentlig hvordan AMK-sentralen vekter.. altså at de ikke tar inn over seg at det kan bli et problem at de ikke sier ifra til oss at den er oppdatert. Eller at det kunne ha ligget der som en alarm, hvis det blir en endring. For veldig ofte sitter de og skriver.. du sitter fortsatt i samtale med pasienten når de sender oss ut også sitter de og skriver. Også kommer det for hver gang de da er ferdig med.. trykker enter da, så kommer de inn på min skjerm, da kunne det komme et pip på et eller annet vis.

M: For nå kommer det ingen lyd i det hele tatt? (1 rister på hodet) Nei.

2: Men alle sånne tings, eller hjelpemidler da, som vi skal få feks da for å håndtere masseskader og sånn, de må være ganske like, eller basert på det vi bruker daglig.

1: Ja, nettopp, og det er derfor jeg også sier at dette kan du bruke.. kan brukes.. altså hvis vi tar utgangspunkt i de prinsippene vi nå har snakket om da, elektronisk journal, stemmestyrt skriving, og video/audio-overføring fra meg.. det jeg ser og hører til de som sitter inne, så er det noe vi kan bruke i det daglige som kan oppskaleres til å gjelde en større situasjon. Også må det være enkelt å bruke! Det må være "paramedic proof" som vi sier!

E: Ja, vi hadde tilsvarende møte med politiet her i forrige uke sammen med en annen student, og de brukte utrykket "politisikkert", så.. Det er tydlig at man har samme holdning til seg selv der!

1: Jaja! Det som skal ut i en sykebil, det bør ha bestått alle NASA-tester.

2: Men det som.. Hvis vi tar en pasient med en alvorlig allergisk reaksjon. La oss is at: "Du har spist nøtter, du får ikke puste, (henviser til 1) og jeg kommer". Så kan det være ganske allright hvis vi kunne ha tatt et lite sånn øyeblikksvideo av deg, ikkesant: "Sånn var du", og sendt av gårde til doktoren. Også har jo (henviser til 1) og jeg gjort de tingene vi skal sånn at du er sånn bortimot frisk, men du må på sykehus. Og når vi kommer på sykehuset så fremstår jo du som frisk. Ikkesant, så blir det bare mitt ord på "det var du ikke".

M: Jeg skjønner.. Så litt mer dokumentering?

2: Ja, for da kan faktisk pasientene bli tatt litt mer alvorlig. Typisk hjertesviktpasienter som har vann i lungene pga hjerte er i ferd med å svikte..

1: Det er så dårlig at det bobler ut av munnen på deg..

2: Lyserødt skum kommer ut av munn, ikkesant, også gjør vi de tingene. Så får vi på en måte stabilisert og dratt av gårde.

1: Så er de friske og rosa i kinna sine når vi kommer frem, ikkesant. Fordi vi har gitt en riktig behandling. Også tror de rett og slett ikke på oss!

E: Og de husker ikke noe av det som har skjedd, er det det?

2: jo! Men de som mottar!

E: Legene husker ikke nei. Nei, nei legene..

1: Det kan jo ikke ha vært *så* ille, sier de ikkesant.

E: Er det sånn profesjonsgreie her? Sånn at de tror...

2: Nei, altså det har noe med at.. Da vil jo jeg melde inn til sykehuset at vi kommer raskt inn med et lungeødem. Og da dukker jo de symptomene som jeg ser opp i hodet til legen, også kommer jo vi frem, også er ikke de symptomene der mer.

1: Altså dette er ikke et stort problem, men det er ganske stor forskjell på å jobbe prehospitalt, og inhospitalt. En vanlig lege på en lungepost han ser pasienter som har en kronisk lungesvikt og noen som har en akutt lungesvikt som er symptombehandlet. Det er veldig sjeldent at han ser disse dramatiske tingene, hvordan det fremstiller seg ute. Har kanskje ikke sett det siden han kjørte sykebesøk som ung turnuskandidat. Og det dreier seg ikke om mistro til hverandre, men noen ganger hadde det vært fint å latt de se hvor dårlig det egentlig var da vi kom. Også er det en annen ting også, og det er at i Oslo så har vi da en legebemannet ambulanse. Eller en legebil, som dekker hele byen. Men da oppstår det ganske ofte samtidighetskonflikter. Den brukes jo i all hovedsak til opplæring av oss egentlig. Det er den vi er på. Sammen med anestesilege. Men noen ganger blir den brukt på ting som ikke er så veldig dramatisk, også oppstår det en kjempedramatisk situasjon på andre siden av byen. Det er klart at hvis de da bare kunne ha skrudd på kameraet sitt, også kunne vi da ha sitti i den bilen og sett hva som skjedde der ute, så kunne vi ha gitt de mye mer relevante råd. Eller at den informasjonen går inn til sykehus og at en eller annen lege.. Feks på hjerteinfarkter, så har vi den teknologien idag at da tar vi en tomkanal EKG-måling som viser patologi, også overfører vi det via GPS.. GSM mener jeg..

E: GPRS kanskje?

1: Ja, til sykehuset, også går en alarm på intensiven, også løper en doktor til en skjerm også ser han det EKG. Det er alt han ser. Også ringer han oss opp igjen også spør han "hvordan er" ditt og datt og hvordan ser han ut osv. I den sammenhengen også så kan jeg.. Er jeg ganske sikker på at det hadde vært nyttig for den kardeologen som tar imot det EKGet å se hele scenarioet ute. Også omgivelsene, hvordan pasienten har det hjemme hos seg selv, feks. Sånn at en sånn teknologi som dette her kunne vært nyttig generelt for ambulansetjenesten i veldig mange, ikke alle, men i veldig mange sammenhenger. De ville sikkert blitt brukt flere ganger om dagen, men spesielt på et større skadested. Uavhengig om pasienten har.. Om ressursene er dekkende eller ikke.

E: Men du, den der legebemannede sykebilen. Hvem er det som bestemmer hvor den skal..?

1: AMK.

E: Det er AMK?

1: Mhm. Men altså vi har jo på den bilen også anledning til å gå inn å si at "dette oppdraget her høres ut som.. hvis vi hører det går ut et oppdrag, så høres det ut som et oppdrag som vi burde dra på, så kan det hende at vi sier at vi setter retning, og at vi er i nærheten der. Hvis vi er ledige. Det er langt vanskeligere for legen eller oss å si at dette oppdraget her høres ikke ut som et oppdrag for oss, send en annen sykebil. Fordi at da snakker vi profesjonsstrid, for da er det sånn at dette er ikke bra nok for deg liksom? Du vil liksom ha noe..

E: Men er det tilsvarende med feks et lege i et ambulansehelikopter?

1: Ja, legehelikopteret på lørenskog, det står 2 stk der, de har også biler, så de kan sette seg i bilene og kjøre, istedenfor å dra med helikopteret hvis det er i nærområdet sitt.

2: Og de kunne også hatt veldig nytte av noe visuelt. I forhold til, for da kan de begynne å..

E: Landingsplass kanskje også, jeg vet ikke, nei?

2: Nei, altså, men.. Forberede der.. Medisiner, utstyr, gjøre klart, ikkesant.

E: Men det er lege i rednings.. Nei i legehelikopteret?

2: Ja.

1: Ja, også i redningshelikopterene. Du har redningstjenesten og luftambulansetjenesten er to forskjellige.. Altså redningstjenesten, 330-skvadronen, den rapporterer jo da til HRS, mens de små legehelikopterene de er en del av helsevesenet.

E: Ja.

M: Har de skjermer i disse helikopterene, på lik linje som ambulansene?

1: Ja.

M: Det er det samme systemet?

1: De har.. De har.. Det blei jeg litt usikker jeg.. Men det er hvertfall.. altså..

E: Jeg tror kanskje de har noe LOCUS-greier der og, men det er en litt annen navigasjonsbehov da.

1: Vi bruker NAF-veibok, bruker vi.

E: Men, bare sånn at jeg husker det, du nevnte noe sånn lokale redningssentral her, det er bare noe som opprettes i veldig store hendelser det, er det det?

1: Nei, LRS opprettes egentlig ganske raskt.

E: Men det opprettes, det er ikke noe permanent?

1: Det opprettes på sykehuset.. Nei, opprettes på politikammeret, også blir det da sendt en fra sykehuset dit. Når jeg snakker om LRS så mener jeg at det blir opprettet et KO inne på Ullevål Sykehus. Vi rapporterer jo til Ullevål Sykehus, så det er Ullevål Sykehus som har ansvar for, feks fordelingen. Mellom de andre sykehusene og seg selv. De som sitter der inne de har da behov for å se dette.

E: Og det er noe annet igjen enn en stab?

1: Nei, det er en stab vi snakker om nå.

E: Så når Politi oppretter stab ved en stor hendelse, så vil det være en LRS altså?

1: Ja, det vil det?(henvender seg til 2)

2: Ja, det er det som er på politikammeret. Og der er det helse, brann og politi.

1: Ja, det er flere der..

2: Også drar de inn de ressursene.

E: Og de har liksom hele den boka der, med roller i dette her. Så den stab-funksjoenen den kjenner vi en del av teorien da..

1: I det øyeblikket vi oppretter en stab, så er det da opp til hovedredningssentralen å delegere videre styring til den staben eller ikke, tror jeg. Altså det her er jo mer Politiet sin greie. Men det jeg snakker om det er den staben som opprettes på Ullevål Sykehus, de som da skal fordele pasienter til seg selv eller til andre sykehus.

E: Så det blir også en slags LRS altså? Helsevesenets egen..

1: Ja, Helse-RS.

M: Det var ikke det samme som du kalte "traumeteamet"?

2: Nei.

1: Nei, traumeteamet det er.. altså det går en traumealarm på Ullevål hvis jeg er på en pasient som er..

2: Påkjørt?

1: Ja, kan du si.. eller.. ja, har fått forkommen etter en høy energiutløsning feks, så ser jeg at denne pasienten her den har behov for en rask screening-intervesjon av et sånt traumeteam. Og da vasler jeg om det, og så går en alarm, og da slipper kirurgen kniven sin, også lab'en slukker røntgen-røret sitt og alle venter i mottak da lab.. Nei, lab'en sier jeg.. Røntgen og lab og sykepleiere og anestesi og kirurger i forskjellige valører.'

M: Så det er topp-prioritet?

1: Da kommer vi inn med en pasient rett inn på en sånn..

E: Dette er vel knyttet til akuttmottak og alt det?

1: Ja, alle møter på akuttmottak, og det er en egen traumestue der som kan ta tre pasienter.

M: Er det kun hvis det er "rød", eller er det..?

2: Ja.

1: Ja, det er pasienter som er ustabile.

2: Mhm. Så man får gjort noe fort.

M: Ja.

E: Ok, så det er ikke liksom kontinuerlig bemannet det altså?

1: Nei. Nei, nei!

E: Det er noe som er.. De gjør andre ting..?

1: De slipper det de har.

E: Men de gjør ikke ting som de ikke kan slippe?

2: Nei.

1: Antageligvis ikke. Isåfall.. eller hvertfall ikke som ingen kan ta over!

2: De som driver med bypass-operasjonen din slipper..?

1: Ja, men ikke sant, det er thorax-kirurg, det er neurokirurg, det er anestesi, det er gastrokirurg, det er røntgen, det er lab, det er mottak med sykepleiere derfra, og..

E: Ja, alle de detaljene er ikke så..

1: Ja. Det er fryktelig folksomt kan du si!

2: Disse tekniske løsningene, som vi nå har, holdt jeg på å si, drolta rundt. Hvis de skal fungere i en hektisk, stor situasjon, så er jeg ganske sikker på at vi er nødt til å ha den der lille dagligdagse teknologien på plass!

E: Ja, det var den skalerbarheten som du var inne på istad også, at du..

2: Ikkesant! Så man kan bygge fra den der "allergien" din, ikkesant? Sånn at jeg kan sende det bildet, ikkesant?

M: Ja.

E: Men sånn.. Jeg regner med at trafikkulykker feks, det er dagligdags nærmest?

1: Ja.

E: Og det er sånn mellom.. Kan jo være fra små til mellomstore, til ganske alvorlige ting da?

1: Når vi kommer frem, ikkesant, så er en av de tingene som kirurgen er opptatt av, det er selve skadestedet. Skader på bilen, altså dette vi kaller for nybils.. eller "bilanatomi" kaller vi det, egentlig da.

E: Ja.

1: Særlig nybilsanatomi. Vi driver og forsker en del på det også.

E: Ok.

1: .. som går på hvordan, hva skal jeg si, sette skadene på bilen i sammenheng med skadene på pasienten.

E: Feks, hvis du har en gammel bil så er den mere skadet enn på nye, og sånne ting?

1: Jo, du har det, også.. Det går på sånn energiutløsning, ikkesant. Hvordan.. Hvor er det nedfallet ligger, altså hvis to biler møtes sånn, så får du et nedfall av vrakdeler, så hvis da vrakene står sånn (Illustrerer med hendene på bordet).. Altså hvis vrakene står her, og nedfallet ligger der (illustrerer en stor avstand mellom vrak og nedfall), så vil det si at en av disse bilene har hatt negativ stopp-energi, dvs at de har møttes der, også har de hoppet videre sånn (illustrerer med hendene på bordet). Dvs at den bilen der (Viser til den bilen med negativ stoppenergi), den har blitt utsatt for relativt store energimengder. Og energi er proposjonalt med traumer. Det er jo da utløsningen av den energien som er interessant, og hvordan vi greier å gjøre en myk oppbremsing av organismen. Altså med airbager og beltestrammere og.. Ja altså kollapsbare strukturer i bilen og sånne ting. Og det er klart at en kirurg hadde hatt god nytte av å se på en skjerm også se at jeg tar et overblikk over dette skadestedet, før jeg går inn i selve vraket og begynner å se på pasientene.

M: Ja.

1: Så et oversikts-aspektet.. det er de alltid interessert i, det er de første de spør om, det er det første de vil vite, ikkesant? Hastigheter, skade på..

E: Men det er kanskje noe som du kunne ha behov for å ta opp det, og sende senere? For det er ikke sikkert at du har kontakt, vel, med de som skal behandle når du kommer?

1: Nei, men de kommer jo 5 minutter før jeg kommer til sykehus, men da kan de gå inn, også kan de.. for da.. hvis den er recorda og sendt fortløpende, la oss si hvert 5. sekund, så kan de gå inn, også kan de ta disse snuttene frem, også kan de spole seg bortover også kan de se.. skal vi se, der har de kommet frem til vraket ja, ikkesant, også spoler de seg bare raskt bort, så de slipper å se meg dilte frem og tilbake. Et kamera som går sånn, ikkesant, også ser de plutselig at her er vi inne i vraket ja, og da vil de da iløpet av noen sekunder kunne innhente seg veldig mye informasjon om.. Ja, hvordan sitter pasienten, ikkesant. Befant han seg i hattehylla bak? Det hender det jo at de gjør, ikkesant, og.. Det kan hende jeg glemmer å si noe når vi kommer ned.. Altså, han her satt og kjørte bilen, men når vi fant han så lå han i hattehylla! Det kan det hende jeg glemmer å si.

E: Jeg trodde at pasientene stort sett beveget seg motsatt vei jeg? Altså at de fortsatte i bilens retning, og ikke motsatt vei?

1: Ja, det er ikke alltid, det kommer an på hva du treffer først det, ikkesant.

2: Du kan ha rundvelt og..

1: Ja, eller bounce-off effekten!

E: Jeg tenkte også på det med, som du.. Det var egentlig noe annet jeg skulle spørre om, men det var veldig interessant dette her da. Så, jeg tenkte liksom på en sånn store hendelser, dere.. Jeg forstår det ut ifra hva dere sier at de er ikke så veldig ofte? Så du kan ikke ha noen løsninger som du kun vil bruke der, fordi de vil dere ikke kunne bruke, for da har dere ikke noe erfaring med de? Men, liksom hvor ofte.. Du hadde en betegnelse på det i starten, en..

2: Masseskade?

E: Hva? En masseskade! En hendelse masseskade. Omtrent hvor ofte regner du at noe sånt..

2: Nei det er sjeldent.

1: Du har jo skrevet oppgave på (henviser til 2)..

2: I Norge så er jo det sjeldent! I Norge så er vi jo strengt tatt helt elendig på dette. Og derfor..

1: Det er gode planer!

2: Ja, jaja, men altså.. En av årsakene til at vi er elendige på dette her er at vi har svært liten tid til å trene - å øve. Lite ressurser. Sånn at å da kunne hatt en eller annen som kunne ha gitt ordre direkte til folk, ikksant? For at vi er dårlig på det, så greit er det! Så det er sjeldent!

1: For å si det sånn.. Jeg kan tenke meg at en situasjon der hvor mye av korpset er innvolvert, og jobber.. Altså det er veldig ofte vi blir sendt ut, rubbel og bit, også blir du stående på en eller annen samleplass også blir du sendt ut igjen. Hvis du ser bort ifra det, altså de der hvor.. du kan si mesteparten av korpset er innvolvert, og handler, så skjer vel ikke det hvert år. Hvis vi tenker oss en situasjon der ressursene ikke er tilstrekkelige for omfanget, så kan jeg tenke meg det skjer et sted mellom hvert 5. og hvert 10.år. Siste vi hadde nå var vel den der.. den hendelsen.. det var jo ikke veldig mange skadde der da, men det var veldig uoversiklig..

E: Den nede på Sjursøya?

1: Nettopp! Fordi at da.. Ikkesant, det er ikke alltid antall pasienter som er det toneangivende, men littegranne komplisiteten på skadestedet også. Så der må man jo si at de var i jobb.. altså da forberedte man samleplass og sånn. Så det er ikke veldig ofte altså!

E: Men du har jo.. det er jo noen delelinjer mellom der da? Feks store trafikkulykker er det jo.. de er vel jevnlige, selv om de liksom ikke er daglige da, så.. Hvis vi snakker om noe sånn hvor det er 4 - 5 biler innvolvert og.. i en tunell eller..

1: Hvis du tenker deg at.. Jessheim da, da får du jo en skikkelig stjernesmell oppover mot Gardermoen, og..

2: Der var det 7 stk her oppe ved Lillestrøm for ikke lenge siden.

1: Ja. Ikkesant, og det er for dem en katastrofe, ikkesant, da har de ikke nok ressurser og det tar tid før helikopterne kommer. Helikopterne kan ta 1 av gangen, man må bestemme seg for hvem er det som skal kjøres, hvem skal vi begynne å.. Er det kanskje.. Lønner deg seg for meg å begynne å kjøre denne pasienten nå fremfor å vente på at helikopteret kommer? Sånne beslutninger er vanskelige å ta når du står ute på skadestedet. Og det er klart at, hvis man da.. Selv om det nok sannsynligvis også er situasjoner som relativt fort er over, og som man.. Blir ikke liggende i timesvis og blir kalde på samleplass på et sånt skadested heller.

2: Det som ofte er, man.. ellers rundt omkring i verden gjør, det er rett og slett at man.. den som kommer på skadested først - han sannsynliggjør et tidsaspekt, og det er +/- 2 timer.. ikkesant, "vil alle disse pasientene være på sykehus innen to timer" - så er det på en måte en type respons. Er det mer enn to timer, så er det en annen type respons. Det vil feks si det at de..

E: Tilsvarende den type 1 og 2 som du var inne på..

2: Ja, ikkesant. Og det er jo særdeles viktig hvis du da tar.. I østerdalen, ikkesant, og du har da 4 biler som har kræsja.

1: I Gudbrandsdalen smeller det hvertfall skikkelig fra tid til annen.

2: Ikkesant! Og du må velge hvilken retning du skal kjøre.

1: Jeg tror nok det at dette her er litt sånn motsatt proposjonalt med størrelsen på korpset, altså Tromsø feks, der kan du tenke deg et snøskred der oppe, i.. På en søndag formiddag, i godt vær, i et eller annet sted hvor det er mye folk, det er ikke fryktelig mange folk i skredet som skal til før det er en.. Og de ville jo selvfølgelig hatt kjempenytte av at de larvene som går opp og prøver å snuse seg frem i et skredet, at de har muligheten til å overføre data.

E: Jada, jeg har også vært borti.. litt borti snøskred-problematikken med Røde Kors.. Der er det også masse muligheter til å gjøre ting.. Smart med teknologi da..

1: Men ting må lages.. Det som er, jeg tror det.. Det som er riktig approach på sånne teknologiske spørsmål det er "Hva er det vi har bruk for - ofte - som kan brukes, eller som har spesielt god nytte i større sammenhenger?" Des større det er, des mere nytte har du av det. Det gjelder også, hva skal jeg si.. Hva skal jeg kalle det, altså.. Intensiteten i et enkelt oppdrag, altså.. (Henviser til 2) refererer til lungeødem, allergiske sjokkreaksjoner og, jeg snakker om hjerteinnfarkt og om pasientene som i og forseg har.. Så det er veldig dårlig da! Det bør jo bare være 1 pasient, så vil det være nyttig med disse hjelpemidlene.

E: Men feks denne merkingen som du snakket om innledningsvis, vil dere bruke den på en vanlig trafikkulykke?

1: Nei.

E: Hva er det som liksom er grensen før man begynner..

1: Det er når du må gå fra pasienten.

2: Du må gå til..

1: Du må gå til neste..

E: Altså at det er en situasjon hvor du har en triage da?

2: Har du 4 stykker i en bil, så har du rimlig kontroll på dem. Eller 6 stykker i to biler.

1: Sant, det er jo å peke etterhvert som ressursene kommer: Du tar han, og hun tar han og sånn ikkesant. Det vil alltid være en person hos deg. Og la oss si at det er 8 pasienter, og fire sykebiler, så vil det si at det vil ta tid før du kan begynne å transportere ut noen. For du har en mann på hver pasient, også må du kanskje ha to mann i periode på en pasient osv. Og så vet du at, i det øyeblikket du skal dra, så må du være to mann på sykebilen. Allikevel så er ikke det sånn scenario hvor det er nødvendig å merke opp folk.

2: Men det kunne vært.. Det kunne allikevel vært treningsmessig nyttig. Fordi at da gjør man det samme hver gang.

E: Men det vi snakket om feks med sånn klistrelapp i panna, det kunne kanskje vært nyttig allikevel..?

2: Ja! Altså sånn hvis det er 3 stykker, ikkesant, og så ser jeg at det er 3 stykker som er stabile..

1: Du tenker på den der pulsoksymetriteknologien ja?

E: Ja, hvis vi tenker oss noe sånt noe, det kunne kanskje vært nyttig, selvom det ikke er en.. Så du kan tenke deg at den er koblet til merkingen som kunne ha vært nyttig, selv om du ikke har behov for å merke da..

1: Men det er klart at hvis du finner opp en device som på en måte måler pasientens vitalia ved å sette en puck i panna pån så.. Da trenger du ikke å..

2: .. jobbe mer!

1: .. fullføre doktorgraden din!

E: Jeg har ingen ambisjoner..

1: Da kan du kjøpe deg hytte i Kragerø.

M: Da kan du kjøpe hele Kragerø!

1: Ja, da kan du kjøpe Kragerø!

E: Neida, det er vel ikke.. Hvertfall ikke innenfor mitt kompetanseområde.. Jeg har vel kolleger, som sagt, som jobber med sånne.. Sånn biometriske løsninger. Men de tror jeg stort sett kjøper hyllevare for det da.

M: Kan jeg nå bare.. Nå begynner vi å få litt dårlig tid så..? (Henvender seg til E)

E: Ja!

M: Kommunikasjonen mellom personellet på.. Utenfor ambulansen, er det bare verbalt?

1: Ja.

M: Det er ikke noe teknologi, ikke noe..

1: Ja også håndverbalt!

M: Ja, greit. Men det er ikke noe sånn intercom eller..?

1: Nei. Og det ser jeg for meg! Altså jeg kunne godt tenkt meg et hjelpemiddel som hadde hengt på hodet mitt fra jeg gikk på jobb jeg egentlig, som jeg kunne ha switcha mellom sambandet mitt, og med intercom med makkeren min..

M: Ja.

1: Og, som hadde hatt, hva skal jeg si, flere sånne "inter-facer".

E: Ja for jeg ville også tro at i den situasjonen du kanskje var ferdig med en ting, og du er klar egentlig til å begynne å kjøre pasienter, så vet du kanskje ikke hvor makkeren din er?

1: Det hender!

E: Ja, så: "Hvor er du, hva gjør du, nå er jeg klar, når er du klar til å kunne frakte?"

1: Ja.

2: Ikkesant!

1: Eller at han står kanskje i bilen, og jeg står inne, også kan du bare gi meg tidene feks. Istedenfor å fly ut og inn. Det er masse sånn.. Muligheten til å kunne.. Jeg vet ikke, hvordan er den blåtann-teknologien nå? Er den 100 meters, eller er det 10 meters..? (Henvender seg til E)

E: Eh.. Jeg tror nok den er.. Samme måte som.. Den er nok ikke noe mindre sånn infrastrukturutsatt enn VHFen altså. Den er nesten klar sikt og avhengig av vær altså.

1: Ja.

E: Jeg prøvde sånn headset, sånn trådløst headset koblet til mobilen til en kollega, når i førsteetasje, også gikk jeg opp igjennom trappene, og da gikk jeg en etasje opp også begynte det å hakke liksom. Men det er andre teknologier der også da.

2: Kommunikasjonen, altså det er jo en av kjempeutfordringene, dette her med.. Altså du har kommunikasjonen med de som jobber på et sted. Men samtidig så går det fryktelig mye kommuniskasjon ut fra stedet, og de blir brukt de samme, holdt jeg på å si, linjene da. Ikkesant, sånn at det kan jo være det at jeg må vente i 3 minutter for å få sagt noe til (Henviser til 1)! Fordi at det er så mye kjattring på radioen!

1: Ja det nytter ikke at det går på samme frekvens!

E: Men dere har radio, sånn som det er nå?

1: Jajaja! Men arbeidsfrekvensen den er jo styrt i sånne sammenhenger! Der er det jo bare kommunikasjon mellom KO og den enkelte som skal skje. Det skal ikke være noe krysskommunikasjon da.

2: Så.. Og derfor, feks.. Nå har vi referert til Israel et par ganger, men det er jo fordi at vi har jo hatt et sånt utvekslingsprogram mellom Palestinerne, Israel og Norge, så vi har jo jobba hos hverandre.

1: Vi har vært der flere ganger! Og blant annet også sett hvordan de gjør dette greiene.. De kan dette!

2: Og de.. De har gått.. De har funnet ut at på et skadested så bruker man ropert!

1: M-m! De bruker megafoner de! Det er skikkelig Low-tech!

2: Nettopp fordi det mangler dette andre.. Det blir så mye kjattring på alt det andre, ikkesant! Sånn at når jeg som en leder skal gi en ordre, ikkesant, at: "Du søker sektor 2". Så bruker jeg.. Så brukes megafonen!

M: Ok!

E: Det er skikkelig Lo-fi altså!

2: Ja, ikkesant! Også stiller han seg gjerne da på taket på en sykebil. Ikkesant?

M: Men i en sykebil så er det bare to personer?

2: Ja

M: Alltid?

2: Det er noen ganger 3.

M: Hvorfor er det 3?

1: Lærling. Lærling eller legeambulanse.

M: Ok.

E: For det høres liksom ut på noe av hva dere sa her, at det kunne ha vært fornuftig å hatt mere.. eller en annen måte å frakte folk ut til..

1: Vi sloss fortsatt for å få tomannsbetjente biler.. Det er ikke fryktelig lenge siden det ble tomannsbetjente biler over hele landet! Det er bare noen få år siden.

E: Så det var enmannsbetjente før det altså?

1: Jaja, du måtte vente til neste bil som kom og kunne: "Hei, kan du hjelpe meg å bare tar du tak i beina hans der så tar jeg tak i hodet der også.."

M: Jo, men på sånne store øvelser så hadde det vel kanskje vært greit å bare kunne trykke på en knapp og si "her er en stor greie, og få med flere leger som sitter på i ambulansen til skadestedet"?

1: Nei.

M: Nei?

1: Fordi at det er utenfor grensesnittet dems. De vet ikke hvordan de skal te seg der ute!

M: Ok.

1: Så det.. Det er samme som å si at jeg trenger å åpne flere operasjonsstuer, også lurer de på om jeg kan stikke opp og begynne å skjære!

M: Ja, ok.

1: Det blir litt på samme måten egentlig. Du kan.. Det er ikke overflødig kompetanse! Altså de er kunnskapsrike nok, men det kan.. Altså de har ikke noe kompetanse på å ikke snuble i vrakdeler og vet ikke hvordan de skal løfte folk, løper inn.. Altså eksempler på det, ikkesant, når det har kommet dit leger ifra sykehuset så løper de rett inn i skadestedet og skader seg selv. Så det..

M: Det er ikke heldig.

1: Nei, det er jo ikke det. Og det er ikke noen dissing av dem det, det er bare det at det kan de ikke. Også er viljen mye høyere enn evnen, og det er jo også et veldig viktig poeng, at man må styre viljen til folk.

E: Men du nevnte snøskred her istad, det har vært veldig inn i år da, det har vært veldig mye av det. Er det noen spesielle utfordringer i..

1: Overhode ikke hos oss.

E: Nei.. Det er dette med kaldt og sånn da, som er..

1: Ja vi har jo mye mer..

E: Tidsaspektet kan jo forsåvidt annerledes der..

1: Urbane områder har mye mere hypoterme pasienter, enn der man skulle tro, nemlig i mer rurale områder. Fordi at her går folk i nettingstrømper og høyhæla sko, og blir fulle og snubler og slår seg i hodet sitt og besvimer, også ligger de i 20 minutter, og da er de kalde altså! Jeg har sikkert hatt mye mer kalde pasienter her enn de fleste andre.

M: Hvis det er kaldt, bruker dere hansker? Eller votter, eller noe sånt noe?

1: Nei, vi bruker gummihansker vi vettu.

2: Vi har det, vi har det i bilen.

1: Vi har hansker ja.. Det er sjeldent vi bruker de altså.

M: Ja. Det er ikke noe..

1: Men jeg blir stående ute på brann og sånn.

M: Men dere bruker alltid gummihansker?

1: Eh ja.

M: Ok.

1: Og ihvertfall på sånne ting som dette her.

E: Må de av igjen da, før du skal trykke på skjermen til LOCUS-systemet?

1: Eh, Ja vi tar de av oss når vi setter oss forran for å kjøre, så gjør vi det.

2: Men det er noen ganger så, at vi tar på feks altså 3 par utenpå hverandre. Ikkesant? Så du bare tar av..

E: Så du bare tar av etterhvert som du har behov for å bli sterili igjen ja, noenlunde?

2: Ikkesant! Ja.

1: Men det hører med til sjeldenhetene, men..

2: Men jeg har lært det nå, det funker bra!

1: Du er flink du! Det er flere som har stilt spørsmål..

M: Men er det noe veldig vanlige arbeidsoppgaver utenfor ambulansen som skiller seg ut mye mer vanlig enn alle andre oppdrag?

1: Det er det logistiske aspektet av jobben som selvfølgelig er det mest vanlige! De pasientene vi ikke trenger å gjøre noe annet med enn å forflytte de.

M: Ja.

1: Altså vi har jo da.. Altså vi har jo 3 hovedoppgaver som jeg sier når vi driver med opplæring av folk at de må tenke på 3 ting: Det er at de skal gjøre diagnostiske oppgaver, de skal gjøre terapautiske oppgaver og de skal gjøre logisiske oppgaver. Og hvilket utstyr er det de har til hva. Sånn som en båre er jo klart et logistisk hjelpemiddel, ikkesant. Men det kan også være et terapautisk hjelpemiddel, i den grad du leier pasienten på den måten at han sirkulerer bedre, eller puster bedre.. Bare for å liksom.. Det er liksom det filosofiske aspektet over hele da. Og det diagnostiske går jo på liksom å finne ut hva pasienten feiler sånn rent tentativt, og eventuelt hvilke tiltak som skal iverksettes. Også har vi rene terapautiske oppgaver, altså med tanke på å gi medikamenter, defibrilere, intubere, eller sånne ting som da går ren intervensjon kan du si. Ovenfor pasientens tilstand. Så det er liksom den grunnfilosofiske metaperspektivet på det vi egentlig driver på med, men det som er det.. Det som er grunnen til at det er jeg som gjør det og ingen andre, det er jo fordi at det er et logistisk stykke arbeid oppe i alt dette. Alt går på logistikk. Alle pasientene vi kommer til, de skal jo et annet sted enn der de er! Med de utfordringene det selvfølgelig..

M: Så da når dere henter noen så er det.. Da er det ikke.. Hva slags kommunikasjon gjør dere da? Type dere kommer til et sted..

1: Nei altså jeg.. Det piper i radioen min, også får jeg beskjed om at jeg har en kjørekode 1, og skal til Vettlesensvei. Også går jeg ned i bilen, også ser på skjermen min, og der står det hvorfor jeg skal til Vettlesensvei. Også kvitterer jeg etterhvert hvor jeg er hen i oppdraget, om jeg har kommet frem osv. Også når jeg da kommer ut i bilen og skal dra et sted så kaller jeg på AMK, også ber jeg da om en sykehusplass, avhengig av om det er en kirurgisk eller medisinsk tilstand, og litt på hvor pasienten tilhører hen i helsevesenet, jf hvor han bor. Det er sånn.. Vi har en fordelingsnøkkel på det. Men det er ikke bare det som styrer dette her, men også tilstand og..

E: Ja, hvis du vet hvem det er!

1: Jaja! Også er det tilstand, ikkesant! Det er jo noen ting de ikke kan håndtere på Lovisenberg feks.

M: Så det gjør du når du kommer tilbake til ambulansen?

1: Ja. Det tar jeg med samband, også får jeg beskjed at.. Eller telefon! Også får..

2: Mobiltelefon har det blitt..

1: Ja det er mer det er vanlig nå, fordi det at det er bare de aller dårligste som jeg får AMK til å melde for meg, for da må jeg melde selv da, dvs at da blir jeg satt over i konferanse med sykehuset som jeg vi ha plass på, og så må jeg forsvare sykehusbruken.

2: Og det er en sånn der.. Du ser sånn.. Det er sånn typisk jeg oppfatter som en utfordring. Fordi at jeg vil gjerne få bestilt denne plassen så fort som mulig, men jeg er samtidig nødt til å bruke begge henda mine med å jobbe med pasienten. Ikkesant, og da blir det sånn..

1: Ja. Ikkesant, du har et infarkt da, da haster det. Du du skal til Ullevål, du veit at pasienten har et infarkt, du trenger ikke være kardeolog for å se det, du veit at kardeologien kommer til å si ja. Og da overfører vi, i det øyeblikket du trykker send på defibrelatoren på EKG-maskinen da, så vet du jo hva du skal gjøre, og da begynner du.. Da begynner de hjula å rulle, og du kan ikke stå der og vente på at han skal ringe tilbake igjen og: "Ja, hva blir det til a. "- liksom, da er du.. Han ringer kanskje mens jeg bærer pasienten på gullstol ned trappa. Og da er det liksom litt vanskelig å svare da! Så der har vi jo.. Altså, kjører du sykebil, så burde du hatt 8 armer og helst 4 bein, så du stod støtt!

M: Hva er det som er den største utfordringa deres, er det for få armer og..

1: Ja, få armer og..

2: Få informasjon, og formidla informasjon, og samtidig kunne gjøre..

1: Multitasking er egentlig en utfordring for oss, for vi gjør.. Har alltid behov for å gjøre flere oppgaver, eller flere ting samtidig, og da.. Det gjelder jo både teknologi, men også rein sånn, hva skal jeg si, omkringliggende problemer som ligger i.. som går på dette her med at du kan bare gjøre en ting på en gang, fordi at du bare har to hender feks.

SLUTT PÅ INTERVJU

Appendix 4.
- Observation guide for the collaborative exercise in Stavanger 14.04.2011

Hvordan parkerer de?
Hvordan orienterer de seg i forhold til omgivelsene?

Hvilke sikkerhetsforhånsregler lar de seg begrense av?

Hvordan skaffer de seg oversikt over skadde? (triagerer de?)
-Kategorisering (fargekoder?)
- Posisjon (Koder eller forklaring?)
- Antall (Når og hvordan informerer de videre om det?)

Hvordan formidler de informasjon om skadde til:
- Seg imellom?
- AMK?
- Brann?
- Politi?
- Fagleder?
- Operativ leder?
- Ambulansehelikopter?

Benytter de seg av andre etater når de skal frakte skadde?

Appendix 5.
- Interview guide for the collaborative exercise in Stavanger 14.04.2011

1 Forklar kort, med egne ord, hva du gjorde steg for steg etter at du gikk ut fra ambulansen og til du var tilbake igjen.(10min)

Stikkord (Triagering, fargekode, bruk av samband, Assistanse, organiseringskommunikasjon)

1.2 Hva av utstyr har du med deg ut av ambulansen? (5min)

2.1 Dersom du skulle ha utført en triagering, hvordan ville du gått frem?(10 min)

(EksempelScenario: Eksplosjon i et 10 etasjers kontorbygg)

(Stikkord: grønn/gul/rød/sort-merking, definering av posisjon (Både i landskap og etasje),)

2.2 Hvem har ansvar for å fordele ressursene på bakgrunn av denne triageringen?(1min)

- KORT: Hvordan foregår denne fordelingen?(5min)

3.1 Hvordan foregår kommunikasjonen med: (10 min)

0 – Annet ambulansepersonell

1 - Organisator (Den som organiserer ressursene)?

2 - Sykehuset

3 - Eventuelle medisinsk personell som kan hjelpe med avgjørelser (Lege, sykehus)

3.2 Er du fornøyd med kommunikasjonen? (Hvis ikke, Hvorfor ikke?) **(5 min)**

SPØRSMÅL FRA GYRD OG ERIK: ca 14 minutter

I hvilken form foregår kommunikasjonen mellom dere (brann/politi) og ambulansepersonellet på åstedet? (3 minutter)

Stikkord: Samband(VHF), mobil, via sentral(AMK), muntlig.

Ved en større ulykke med flere skadde enn ambulansepersonellet har kapasitet til å transportere, **i hvilken grad assisterer dere ambulansetjenesten? (8 minutter)**

Stikkord: Medisinsk hjelp, hjelp til å flytte pasienter, hjelp til å triagere, organisatorisk hjelp

Ved slike ulykker blir gjerne ambulansepersonellet opptatt med å holde liv i kritisk skadde personer og kan dermed ikke kjøre ambulansen. **Hadde det i slike tilfeller vært mulig om politibetjenter/brannmenn kan kjøre ambulansene til sykehuset slik at en av ambulansepersonellet pr bil kan bli igjen på åstedet? (3 minutter)**

Appendix 6.
- Interview guide for the interview with a sensor expert at SINTEF

Intervju med sensor ekspert, 12.09.11; Agenda: Sensorteknologi

Sensorene fra plakaten: (Akselleratorer, fuktighet, varme)?

- Hvordan fungerer de?

Har du kjennskap til sensorer som overvåker pust?

- Evt hvor og hvordan må den festes?

Har du kjennskap til sensorer som overvåker kroppstemperatur?

- Evt hvor og hvordan må den festes?

Har du kjennskap til sensorer som overvåker puls?

- Evt hvor og hvordan må den festes?

Har du kjennskap til sensorer som overvåker hjerneaktivitet?

- Evt hvor og hvordan må den festes?

Har du kjennskap til andre sensorer som kan hjelpe til med å avgjøre tilstanden til en pasient? (bevissthet, puls, pust, kroppstemperatur, luftkvalitet)

Appendix 7.
- Findings from the interview with a sensor expert at SINTEF

The interview was conducted with an expert in bioinstrumenting at SINTEF Oslo. She had, amongst other projects, been working on a system to improve decision support for subjects exposed to heat stress. This system uses sensory data to determine the subjects current health status, in this research firemen, enabeling quicker and more detailed risk assessments of the situation. The data collected by the sensors are heart rate, skin temperature and accelerametors.

Both heart rate and skin temperatures are key information when it comes to patient status assessments. Accelerametors conserned with the subjects movements however will not be as important when it comes to patient status assessments, primarily because patients don't move around in the same way firemen does.

There is also possible with breath monitoring. This can be accomplished through registring of the patients breast-volume. Breath monitoring can also be accomplished through a breathing mask, but this system would be too time-consuming, as the system has to be completly sealed in order to work, and the equipment would be too heavy.This means that to monitor the patients breathing one need to have sensors attached in the breast-area on the patient. Seeberg personally finds these data difficult to interpret as most people breath in different ways. She does however achnowledge that the sensors easily could tell if a patient is breathing or not, and that this data would be useful.

Another way to monitor both breath and intoxication is through pulse oximetry. This is a sensor that is easily attached to one finger of the patients. It uses ultraviolet light to scan the blood of the patient, and reveals what gasses, and how much of them there is in the bloodstream. This technology is now available as mobile technology, where the sensor is cordless with blueTooth technology. The data is sent to a cellphone. The drawback of this technology is that it has to be placed on fingers or toes to enable the scan. If a patient is suffering from bloodloss or hypothermia the body shuts down the bloodstream to the limbs, and the sensor will give data indicating that the patient is dead.

Core temperature is another indicator to a patients status. But in order to measure this one need to get a sensor into the core of the patient, something not practically or hygienically possible outside a hospital. One could however monitor the skin temperature at one or more locations of the body. More sensors reveals a more thorough picture of the patiens current bodily temperature, but is also more timeconsuming for the paramedics applying these sensors onto the patients body, eventhough applying a skin temperature sensor is easy; it just has to touch the skin somewhere. More sensors also means more weight and consumes more space, eventhough these sensors are light and small. If one should limit the temperature monitoring to one sensor it is important that the sensor is put at a place where skin temperature doesn't vary much from the core temperature. This means either torso or head.

Heart rate is an improtant parameter when assessing a patients status. Therefore this system should have a sensor monitoring this. Seeberg has seen many different attempts at monitoring this, but has never seen any location better suited for heart rate-sensoring than the torso. Sensors put in other parts of the body gives too inconsistent and vague data to serve as monitoring data. She does say however that PULSOKSYMETRI qickly reveals if the blood lacks oxygen from not breathing, but as described earlier the limbs are not great areas to put sensors.

When asked about Brainwaves Seeberg points out that they are not easily monitored, nor easily interpreted and requires many sensors on precise areas of the scull. This is not something that paramedics can use outside of hospital.

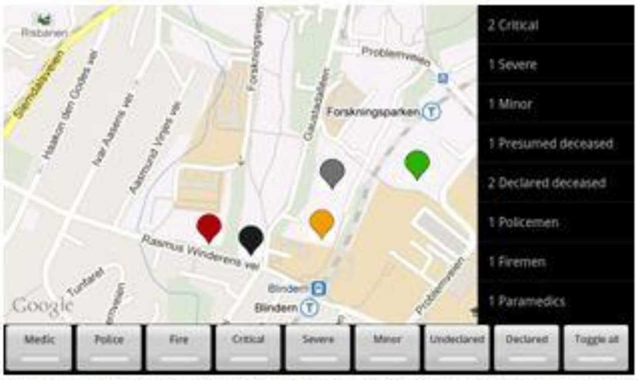
In the interview she also mentions sweat sensors as a possibility. These sensors either measures the level of moist or the electrical resistance of the skin. They are both easy to use, small and light.

Other sensors:

EMG = Muscular activity
Magnetometer = ”Compass movements”
Gyroskop = Movement sensors

Discussing sensors with an expert has made it clear that the easiest and best way of monitoring a patient in the field is through the placing a multisensory device in the breast-area of the patient. There are two ways of doing this: 1) Using a belt with all the sensors attached, and placing this around the patients torso. This is what the sensor expert did when collecting heart rate, skin temperature and movement data. Monitoring breath could be done with sensors registring the changes in size of the belt, which has to be elastic. A sweat sensor could replace the movement sensors. 2) One could place two electrodes with some variant of glue or tape to the patients chest. This would enable the same sensory data as with the belt; Heart rate, skin temperature, breath and sweat monitoring.

Appendix 8.
- Questionnaire about colors



Over ser du 5 ikoner i et kart. Hvert ikon representerer en pasient som har blitt gitt en prioriteringsgrad. Tenk deg at du er leder for ambulansearbeiderene:
I hvilken rekkefølge ville du ha prioritert å sende hjelp til pasientene?

Appendix 9.
- Icons designed for visualization of patient priority and emergency resources in a map.

For: Mads Helno Jahren, used in his master thesis.

By: Joakim Bording & Mads Helno Jahren