Developing tools in educational applications to promote learning

Johan Moritz (dit04jmz@cs.umu.se)

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Supervisor at CS-UmU: Anders Broberg
Examiner: Jerry Eriksson

Umeå University
Department of Computing Science
SE-901 87 UMEÅ
SWEDEN
Abstract

The increase in accidents, involving emergency vehicles, the last few years has led to a new approach regarding the drivers’ training. The idea is to find new tools and methodologies to complement the training of emergency drivers. Therefore, an application, that is supposed to give emergency drivers the opportunity to improve their understanding and risk awareness, has been requested. This projects goal has been to develop a working prototype of such an application, user-test it and acquire knowledge on learning to further enhance the prototype into a finished product. The results come in the form of a design document, which addresses what kind of support is needed for the application to fill its purpose.
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1. Introduction

The purpose with this master thesis project is to develop a web-based learning platform for further education of ambulance drivers. For the application to fill its purpose, some research will be done in the area of human computer interaction, or HCI. However, the application will be created with the main objective to support attitude change. Therefore, the greater focus, and the latter part, of the in-depth studies will be about learning, and how learning can be supported in web-based tools.

This project has its origin in an attempt to reduce accidents involving emergency vehicles. By training the emergency drivers’ cognitive skills, rather than their reflexes, it is believed that this can be achieved [Ker. Roberts, 2008]. Within the EU-funded Nordic Safety and Security or NSS, a project called Utvärdering och utveckling av utryckningsförares utbildning, is conducted. The project is run by AKMC, which is a research unit of Västerbottens län Landsting (VLL) in Sweden.

Research has shown that skilful driving will only reduce the risk of accidents by so much. More importantly is the drivers’ ability to make judgements on the immediate traffic situation, and calculate the risks in a sensible manner. It is believed that this ability can be trained had the driver education consisted of some way of letting the drivers watch and reflect upon their own driving.

The idea is therefore to create an application that will present recordings of actual ambulance call-outs. With the help of this application, the ambulance drivers can answer questions regarding risk-taking as well as reflect on their own driving pattern. The intention is to design this application so that the presentation, in the best way possible, supports learning and hopefully changes the drivers’ attitude. To achieve this, I had to learn more on the subject of learning.

At first, the task has been to make a prototype, or proof of concept, and eventually, as the application is tested, develop it into a finished product. This assignment has been given to Fält Communications, where I have been conducting my master thesis work. Fält sells and develops systems for secure and reliable worldwide communication within logistics, security and industrial automation, and is based in Umeå, Sweden. The tool used in development has been Microsofts’ Silverlight framework, which is used for creating web-applications.
Once the prototype was working, some user tests were carried out. After implementing and testing the application, an in-depth study has been made. In this study, both HCI-techniques, as well as information of means to support learning in a computer-based learning environment has been found. The final work has been to theoretically put together the users’ feedback and the in-depth study guidelines with the existing application and its functions, to form a model on how the application should have been structured if all ideals could be met.

The procedure, or sequence in which this project has been carried out may seem unusual, and it is. In general, when creating a new application, no coding is made before a carefully prepared design has been determined. Due to a wish of having a working version of the application within a time period that did not allowed for a careful design study, the first version was not so well thought out. The development tools used, was new to me, and therefore the method “generate and test” has been frequently used, and can be detected when using the prototype.

### 1.1 Approach

This first chapter of the report has outlined the project, named participants and explained some limitations made. Some background information has also been given, but can be read in detail in chapter 2. Chapter 3 describes the design and implementation of the prototype. The section begins by presenting the specification of requirements. Discussions on how, and why certain choices have been made are also presented here. Chapter 4 will cover the in-depth study, which is divided into two sections. The first section discusses usability, or HCI. The second section is focused on learning, and means to support it. The Fifth chapter will review the user-testing results as well as comparisons made between the findings of the HCI-part of the in-depth study, and the actual application. Finally, chapter 6 will discuss how one can continue to further develop, and enhance this application, by implementing the newly learned knowledge from the latter part of chapter 4, tools to support learning.
2. Background

This chapter explains some background information about why this project is needed, what ideas and research that makes out the basis for the project, and also how the ambulance drivers’ training is conducted today.

2.1 Accident statistics

According to a study made by Akut-och katastrofmedicinskt center (AKMC) at Norrlands universitetssjukhus (NUS), between the years 2003 to 2008, 110 accidents involving ambulance vehicles occurred in Sweden.

Some of those accidents had fatal outcome where four people died. In one case an ambulance driver died, in another a patient. The remaining two killed was in their car when the ambulance hit them from behind. One tenth of the accidents also occurred in this manner. To a large extent, these accidents occurred in inner city crossings in bright daylight [Albertsson. Bylund, 2009].

*It doesn’t occur when it’s slippery or dark; it cannot be blamed on such circumstances*

-Pontus Albertsson Västerbottens kuriren, 21/12 -09.

*Picture 1. Accident between truck and ambulance Umeå Sweden 16/10 -09*
The picture above shows the wreckage of the ambulance that collided with a truck in Umeå, Sweden in late 2009 where one of the ambulances’ drivers lost his life. Following the accident the investigators realized that the ambulance had run a red light and that this was the cause of the crash. An ambulance is of course allowed to break some traffic regulations in an emergency situation, but only if the proper precautions are taken.

In the aftermath of the accident the debate about a specific certificate for ambulance drivers arose.

### 2.2 New Ideas

The ambulance education that has been available up till now has not been quite sufficient, and an initiative, taken by *Västerbottens läns landsting* (VLL), *Akut och katastrofmedicinskt centrum* (AKMC) and other participants for more effective measures, is in progress. The main purpose of this initiative is to improve the way the ambulance drivers undergo their education and training. The work is conducted within the frames of the EU financed project *Nordic Safety and Security* or NSS. The NSS is a project with main purpose to create a centre of competence for security and vulnerability in the north of Sweden.

The NSS-project named *Utveckling och utvärdering av utryckningsförarnas utbildning* (Translation: *Development and evaluation of emergency driver training*)’s aim is to find new tools and methods as a complement to the education. Also an evaluation, regarding the effects the education has on the drivers’ judgement and risk-taking, is particularly interesting. AKMC have, on a scientific basis, started to develop these new evaluation methods partly based on new technology.

The technology referred to is the MIIPS®, or *Mobile Internet IP Server*, from Fält communications. The MIIPS is a mini computer terminal with a Linux operating system. It is equipped with a GPS for remote monitoring and is attached inside the ambulances and connected to the vehicles’ CAN-bus. A video camera has also been installed to record the actual emergency run. All the data of interest is collected and sent over the GSM net to Fält’s server. The data sent to the server consists of; Speed, video, GPS coordinates and G force readings from a G sensor connected to the MIIPS. Gradually more data, such as brake indication, gas consumption and so on, could also be gathered. The GPS is also equipped with
the ISA layer. ISA stands for Intelligent Speed Adaptation and shows the driver the current maximum speed limit. With the ISA layer applied, information about exceeding the speed limit is also stored.

Ways to sort or identify a recording to match a specific driver has been achieved by connecting an RFID-reader to the MIIPS. The drivers have all been handed an RFID-card and when they enter the ambulance the reader will tie the driver in question, to the data. All of the information is stored on the server for the drivers to use and evaluate later in their training.

The purpose with the evaluation is to enhance the reflecting ability by going over the emergency runs step by step. By doing this the drivers get an understanding of what kind of risks they put them selves, and others, in.

2.3 Driver training
The ambulance medical service has earlier trained their drivers in manoeuvring at high speeds, correcting skids on special skidpans, and so on. It is however doubtful if this kind of training has had the desired effect to prevent accidents. An evidence-based study published in Cochrane library (Ker, Roberts et al. 2008) shows a survey of 24 studies of so-called ”post-licence” driver training. Post-licence training refers to further training for those who already have a B-drivers licence. The study presents no evidence that this type of training will reduce accidents.

A Swedish study (Nolen, Engström et al. 2002) however shows that an insight-directed education can have an effect on the drivers in the long-term. The study shows that the education gave positive effects on the driver’s sense of driving with safety margins, keeping a safe distance to the vehicle in front and readiness for overtaking. This, among other things, is the underlying idea that has changed the post-licence training both in name and focus, from previous skidpan training to risk training. This is why the AKMC project, with main focus on methodology and reflection, is needed.

Despite discussions about a new driver training over the last ten years, it has not resulted in new national education programs or any licence demands. There is, however an exhaustive manual describing the aims for ambulance, as well as police training. The manual has its origin in earlier work such as the GDE-matrix (Hatakka et al, 2002) and GADGET. These
projects amounted in different levels of competence a driver should reach to be considered safe and reliable. The manual, and its objectives, works, but the evaluation part is missing, evaluation of the description of aims to see whether the drivers have become more certain in their performance. This is the missing piece that the project is hoping to create. Fält communications has also been given the assignment to implement the presentation of the data, i.e. the graphic user interface or GUI. The implementation and evaluation of this GUI is the essence of this exam-paper.

**SUMMARY**

Due to the frequently recurring accidents, involving ambulances, new tools for training is considered necessary. Areas of interest to be practised are: drivers own judgement, risk-analysis and ability to take in traffic situations in an insightful way. With the assistance of the intended application, the drivers can watch and analyse their driving behaviour step by step.
3. Building the application

This chapter will describe the blueprint, implementation and result of the practical work for this thesis. As mentioned earlier, the procedure this project has been conducted in, is unusual when building a new system. Due to time limits a proper theoretical design could not be done, and hence the practical work had to begin by gradually solve each requirement one by one.

3.1 Specification

The thesis is to design and implement, and later on evaluate an application to support the ambulance drivers in their training, specifically to train their attitude towards potentially risky situations. Once the application is executable, it will be tested on a group of ambulance drivers. Later on the drivers will use the application without a trainee. The application will be web based so that the drivers can use it and work on their own from wherever they wish. The only requirement is a computer with an Internet connection. Some functions and features are mandatory, and have been requested by AKMC.

- **Security**: To protect the recordings from getting into wrong hands, individual login is needed. To further enhance security a SSL-certificate, to provide encryption and secure identification, has also been purchased.

- **Administration**: As this application will hold a large user group, an administrator has to be able to manage the user-accounts, add new users, change user information and so on. The administrator should also have the authority to delete sensitive recordings and data.

- **Support**: Explanations of the different features and functions in the application is crucial as it is supposed to be used without supervision as time goes on. This is solved with a special help-page explaining the different functions.

- **Presentation**: Each chosen emergency run should be presented in the form of: map, recorded video and other data like speed, g-force etc.

- **Media control**: In addition to the mandatory control buttons like play, pause and rewind etc. the recording should also be manoeuvrable from the map. That is, if a position in the route on the map is pressed, the video player will automatically skip to that position in the video recording. All the visual features will be synchronized.
This is merely the skeleton of the application and what it is meant to become. Later on, in future upgrades, the possibility of making annotations, or rating of a specific run, will exist. Other ideas will also be tested and will be discussed in sections later on. The implemented material available following this thesis will be just a little more than a prototype.

3.2 Designing and implementing

The implementing of the application was actually done prior to the theoretical analysis. The reasons for this, somewhat backward procedure, was due to the need of a fast delivery of a functioning prototype. Many developers came into the project at a late stage, and a deadline had to be kept. A proof of concept was created and hence, some of the design guidelines were not followed accurately. The idea is to enhance and upgrade the system as time goes on, making all the important changes accounted for in this thesis.

3.2.1 Development tools

The developing tools used were Microsoft Silverlight, which is a web application framework similar to Adobe Flash. A Silverlight project contains a XAML file, which is an abbreviation of Extensible Application Markup Language, and is based on XML, used to initialize structured values and objects and a code-behind file that can be written in any .NET language, and contains the programming logic. The XAML file usually holds the graphics code, and the code behind file, the events or methods. However, we created an application that did not load all the graphic objects at once. Not until a button is pressed or a method is invoked does the object load.

The first thing was to incorporate, or embed a virtual map into the application. The map would act as an interactive background in the GUI. Different alternatives were considered, and the Bing map-engine was chosen. Bing Maps is a web-mapping service provided as a part of Microsoft’s Bing suite of search engines. The Silverlight Bing Map control and the Bing Maps Web Services SDK comes with ready-to-use methods, such as calculating a route or drawing a plotted route-line, and makes it easy to implement advanced functions in an application (Microsoft 2010). When the map is embedded it functions the same way as it does on the Bing maps website. It has a toolbar for zooming and choices for layout. One can either choose Road view or Aerial view. Road view is standard map graphic, and Aerial view is multiple aerial photos patched together to resemble a satellite image.
3.2.2 Functions
Once the map was implemented, the video recording was to be placed on top of the map. A set of built-in controls is provided in Silverlight such as Buttons, Sliders, Text boxes and Windows etc. Additional controls can also be added either from other Microsoft applications or third parties. Among this wide range of controls, one Expression Media Player exists. The control is part of Microsoft’s Expression Encoder application, which is used for editing and encoding media files. The player is complete with buttons and sliders for controlling the media.

![Picture 2. The Expression Media Player.](image1.jpg)

For speed-presentation another pre-existent control were used. The Circular Gauge made by an American web developer named EvelynT, and licensed under the BSD License, is a XAML-made control equipped with scale background and needle (The Code Project 2010).

![Picture 3. The Circular Gauge.](image2.jpg)
A custom digital speedometer has been created as well, but has not been integrated in the application yet. Although the Circular Gauge is well made, the problem with using someone else’s creation is that the code for that particular control is seldom enclosed when downloading it, or completely visible when adding it to your own application. This was a valuable lesson learned when the G-sensor graph was being implemented.

The first version of the Graph was composed with third party code, and worked satisfying for some time. But when a new function (which enabled the user to reload the page without any additional login) was implemented, a runtime error emerged. It turned out that some components of the third party graph could not load multiple times, and thus made the application crash. This was very frustrating due to the lack of documentation, and unnecessary time was spent for debugging when other issues had higher priority than the graph. The third-party graph was discarded and a graph from the Silverlight Toolbox was used instead.

The last GUI object not accounted for is the speed limit sign. The speed limit sign, or speed limit presenter, was fairly easy to make. It is made out of two circles and a text block. The text block will update any time the ambulance enters a new area with a different speed limit. The font for the text block is taken from Vägverkets (National Road Administration) home page, so that the object becomes an exact imitation of a standard road sign. This is an important and deliberate choice, to try and achieve a natural mapping between the GUI and real life artefacts. This has been the endeavour throughout the making of the application, and even though the road sign and speedometer does not require any pondering, the G-sensor has not got any natural equivalence in general. The way to present this in a customary way is probably obvious only to air force pilots and similar occupations. Since the G-sensor works in three axes, three different presentations are needed. One presentation for right and left-axis is needed, when driving in a curve, another presentation for indicating acceleration or braking, in other words forward and back. The last axis measures the up/down G force and indicates bumps and pits on uneven roads.

A lot of time has been spent on how to solve these presentation problems, and some of the ideas tested were:

Output shown in the same manner as on a cardiac monitor used in hospitals. When the video starts, the G-sensor output is plotted synchronously, in the form of a moving curve. It could
also be compared to a seismograph, used for readings of earthquakes. Another idea was to represent it as sound output indicators, light-bars seen on amplifiers or other sound equipment, bouncing to the rhythm of the music. The idea to direct these bars in x, y and z-axis, was also considered. A similar solution was to represent it as rows of lights lit up or turned off as the sensor value increased or decreases.

The idea finally chosen was a system of coordinates with the G-sensor values on the Y-axis, and time span, from start to stop of the emergency run, on the X-axis. This was achieved with the Silverlight line chart.

*Picture 4. The Silverlight line chart.*
3.2.3 Controls

![Buttons for showing or hiding graphical objects.](image)

Some buttons for controlling the graphic objects was also made. All of the objects are, so called floatable, and can be moved around the screen to be placed at discretion. When all of the data, gathered from the ambulance, is visible (e.g. video, speedometer), the requirement for screen size is increasing. And if additional features are to be implemented, such as brake indication, the screen will get cluttered with information. To this must be added that both the media player and the line chart are resizable, and can alone cover the entire screen. There must hence be possible to control the visibility of these objects as one chooses.

An open/close-button for each of the objects was made, and also a button to control the route: activate/inactivate follow route. When activated, this button centres a dot, representing the ambulance, on the map at all time. If it is a long way emergency run, or if the map is closely zoomed, the dot might go off the screen. However, when activated the map cannot be controlled as easily as it ceases to be draggable.

![Dot representing the ambulance, centred on map.](image)

Two more buttons were made. One button that opens up a help-page containing support on how to operate the application, and another button for returning to the start page (see picture D4 in Appendix D). These buttons are not part of the toolbar (picture 5) that holds the other buttons, simply because they provide different types of functions.
3.3 Finished prototype
When the application was finally put together, and the data files, gathered from the ambulance, was ready to use, the application worked in the following way: Users start by logging on with their previously handed out username and password.

![Login window](image.jpg)

*Picture 7. Login window.*

If the username exists in the drivers-database, and is associated with the password, two lists are presented. The right list contains the emergency runs that has been carried out by this particular user, and the left list contains emergencies were no driver identification has been done, when recorded. The identification is done using RFID technology. When the driver is entering the ambulance, an RFID reader, in the ambulance, starts communicating with the drivers’ RFID card, or “tag”, carried by the driver. The unidentified runs are often due to missing, or broken, RFID cards.
Once the user has chosen an emergency run, the application will load the video recording and the sensor data. The main layout of the interface can be seen in picture 9, and more detailed in appendix D.
4. In-depth study on HCI and Learning

There are several different aspects to take into account when designing a web-based platform for learning. The appearance aspect is somewhat natural, and guidelines on how to present information to users have been thoroughly analysed and tested over the years, and some ideas are more or less timeless. Secondly, the cognitive aspects: Much has been written about this in numerous Human-computer-interaction (HCI) books and papers, and many of the applications have been adopted as standards. Incidentally, layout and graphics is actually included in HCI, hence the appearance aspect is more than just aesthetics. The first section of this in-depth study will be about this. Finally, the learning ability aspect: Learning is a vast field of research, and trying to create a foundation for a sufficient learning environment will be stressed in this essay, and will be discussed in the latter part of this chapter.

4.1 HCI

This first part of the chapter will cover appearance, functionality, and means to prevent ambiguity when using an application.

4.1.1 Appearance

"Attractive things work better", is the heading of the first chapter in Donald A. Normans’ book Emotional design: Why we love (or hate) everyday things (Norman 2004). According to the book, this statement is proven in different experiments. One example is the experiment conducted by Kurosu and Kashimura, two Japanese researchers, in 1995. They had developed two ATM machines. The machines differed only in button and screen layout. One had the buttons and screen arranged attractively, the other had an unattractive layout, and the attractive one was considered easier to use. An Israeli scientist reproduced this test with Israeli subjects and the findings where alike, if not stronger. This tells us that the aesthetic preferences are not culturally dependent, and should apply everywhere. These findings have to do with emotions. Whenever we see something beautiful, our positive emotions come pouring, and research have shown that positive emotions enhance our productivity.

Emotions, we now know, change the way the human mind solves problems – the emotional system changes how the cognitive system operates. So, if aesthetics would change our emotional state, that would explain the mystery …

…positive emotions are critical to learning, curiosity and creative thought.
Furthermore, Norman is saying that when creativity is promoted, the will to try something from a different angle when stuck, is more likely, than if one is feeling anxious or tense.

This state of negative affect leads people to focus upon the details that are giving trouble, and if this fails to provide a solution, they get even more tense, more anxious, and increase their concentration upon those details.

It might be obvious to design something attractive as oppose to something less attractive, and that the former is preferred by most people, however one need to know what is in fact considered attractive.

Norman lists special conditions that are suppose to induce positive emotions, and hence will make the user experience beauty (although Norman uses the word “pretty” and reserves the word “beautiful” for the more complex levels of brain processing described below). Some of these conditions are particularly interesting and can be applied to GUI design. Things like: Bright, highly saturated hues, “soothing” sounds and simple melodies and rhythms, symmetrical, rounded or smooth objects and “sensuous” shapes. These are all conditions that appeal to humans on, what Norman calls, the visceral level of the brain.

The visceral level is one of three different processing levels in the human brain, and manages the automatic impulses, or basic reflexes often hard wired at birth. This originates from our basic needs such as finding shelter and food or stay away from danger. A symmetrical, round apple, lit up open spaces or a mothers humming is preferred over a puddle of mud, dark dense crowds and sudden, unexpected loud sounds. Consequently, visceral design is about how things look, smell and sound. One of Norman's examples of visceral design is the 1961 E-type Jaguar. He claims that it is a car that people fall in love with, and wants to own. Its shaping with soft curves is an example of timelessness. How well it performs or the pricing is of secondary importance. The iMac from Apple is another example. When it first came, the dominant colour style among personal computers was dull grey or other pale shades. According to Norman, the iMacs soft lines and its overall simplicity is what make it timeless. This tells us that the appearance, or the “looks”, of a product, or in this case a GUI, should resemble these conditions that humans seem to prefer. It is easy to test if this level of design is achieved, by putting a viewer in front of the object to be evaluated and wait for the first
spontaneous reaction. The reaction is almost always the experience of the objects’ visceral design, says Norman.
4.1.2 Usability

The second and higher level is the Behavioural level. The behavioural level is the level that contains the processes that control our everyday behaviour. Walking, running or even driving a car, are all actions performed on the behavioural level. When designing for this level, the appearance does not matter as much as how fast, easy or efficient the artefact allows itself to be used for its intended purpose. This is the area where, one of Normans previous books; The Design of Everyday Things (DOET: Norman 1990) was a huge success. In DOET, Norman writes about the term Affordance, originally invented by the perceptual psychologist J. J. Gibson (1977). Normans’ definition of the word affordance is as follows;

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.

Affordances tell us what operations are possible on things. A button can be pressed, a door knob can be turned etc. While DOET concentrated on physical products, in 2004 Norman wrote an essay with emphasis on graphical design (e.g. screen displays). It is called Affordances and design. He distinguishes between real, and perceived affordances. In product design, with physical products, there can be real, as well as perceived, affordances. In screen-based interfaces, the designer controls only the perceived affordances. Even though a computer display might not be touch-sensitive, it still affords pointing. Norman gives a similar example.

Because I can click anytime I want, it is wrong to argue whether a graphical object on the screen "affords clicking." It does. The real question is about the perceived affordance: Does the user perceive that clicking on that location is a meaningful, useful action to perform?

This is about conventions in GUI design, or what Norman calls logical and cultural constraints in DOET. Physical constraint, on the other hand, is closely related to real affordances. A physical constraint can be the physical impossibility to move the cursor outside the screen. Thus, in graphical design the physical constraints play a minor role, and more interesting are the logical and cultural constraints. Logical constraints can be thought of as the only logical actions to perform; if we ask the user to click on 5 locations and only 4 are immediately visible; the person knows, logically, that there is still one location left.
Cultural constraints are conventions learned, and shared by a group of people or an entire culture. We have been taught that moving the scroll wheel of a mouse downwards will make the text move upwards. If the text were to move downwards as well, we would find it confusing, but only because the former convention has already been established.

To get good results in designing for the behavioural level, one has to observe and record how users actually use the objects or services in real life situations. Careful studies of this will help the designer to find simplifications and improvements to the design subject. This is, according to Norman, a problem if one is trying to design items that are brand new products on a completely new market (Norman 2004). Developers who set out to create a new type of word processor or search engine have already a rich empirical basis to work from, but how does one approach the task of designing an artefact that is the first of its kind? The assignment for this thesis resembles that problem as no application predecessor can serve as a model for our application. However, in Affordances and design, Norman mentions four design principles that will help new users understanding what to do, but he states that each has both virtues and drawbacks:

1. **Follow conventional usage, both in the choice of images and the allowable Interactions**
   Convention severely constrains creativity. Following convention may also violate intellectual property laws. Sometimes we wish to introduce a new kind of action for which there are, as yet, no accepted conventions. On the whole, however, unless we follow the major conventions, we are doomed to fail. Those who violate conventions, even when they are convinced that their new method is superior, are doomed to fail. You cannot successfully introduce a non-qwerty keyboard today, or reverse the window scroll bar convention, or suddenly require double-clicking on web links.

2. **Use words to describe the desired action (e.g., "click here" or use labels in front of perceived objects).**
   This is, of course, why menus can be relatively easy to understand: the resulting action is described verbally. (Of course, the method of using the menu has to be learned, and the text still has to be chosen with care, and user tested.) Words alone cannot solve the problem, for there still must be some way of knowing what action and where it is to be done. This requires a convention of highlighting, or outlining, or depiction of an actionable object. It is also well known that single word labels fail for most people. Everyone has a favourite word, but the variety of preferred words is overwhelming.
Words also cause problems with international adoption. Thus, road signs often use graphics; an international standard on road sign graphics exists. Alas, most people do not understand those standards. It is also the case that words are understood more quickly than graphics, even a well-known, understood graphic. Words plus graphics are even more readily understood.

3. **Use metaphor.**

Metaphor is both useful and harmful. The problem with metaphor is that not all users may understand the point. Worse, they may take the metaphor too literally and try to do actions that were not intended. Still, this is one way of training users.

4. **Follow a coherent conceptual model so that once part of the interface is learned, the same principles apply to other parts.**

   Coherent conceptual models are valuable and necessary, but one problem still remains; how does one learn the model in the first place?
   
   - By conventions, words, and metaphors.

The behavioural level is not conscious and that is why we can perform deeds subconsciously while, at the same time, thinking about something completely different, on the reflective level.

4.1.3 **User experience**

The reflective level is what the name suggests, the ability to reflect on prior events or experiences, or to comprehend abstract relationship and find meaning in them. Unlike animals (in general), humans’ posses this capability and our experience will form everything we will face in the future. Although the cultural constraints, mentioned above, come from prior knowledge, reflective design is not about usability as much as the sense created when a product is used, and the message that the use of the product conveys.

All usage of artefacts can be seen as a kind of communication. Not necessarily public communication, like showing off a brand new mobile phone or an expensive watch. It can also be a matter of personal meanings. When we use a specific product we come to think about some significant phase in our life that has had a positive impact on us and therefore we prefer that product to other products, equally usable.
This level is evidently more complex than the previous two levels, and Norman also notes that reflective design is especially difficult to develop. This is partly due to surroundings of the object being developed. Reflective design exceeds the object itself and is very much about the object's context. To design for this level is not that important in an early stage of development.

In product design, the kind of design principles one should apply has a lot to do with marketing, branding, naming and how an item affects the user's self-image. This can of course have some importance when building a learning platform, and principles for better comprehension and reflection will be reviewed in this thesis.

Norman gives an example of an interface where the three levels are in cooperation, Google:

- **Visceral**
  The use of primary colours induces positive emotions. One empty textbox tells our primitive minds that it “must” be filled with something (preferable text).

- **Behavioural**
  The main function (to search) is evident and highly visible. Other functions (tools, settings and search alternatives) are secondary visible. Google uses its logotype for feedback on how many search results the user has received (Gooooooogle: each “o” represents one search result page).

- **Reflective**
  Google makes conscious use of its own logotype to convey the feeling that the site is fun to visit. Google changes its logo depending on the seasons, anniversaries and commemorations.
SUMMARY 4.1

It is important to present an interface that is both beautiful to look at, is clear and follows logical and cultural conventions. Using colours and sounds that appeal to our visceral level of the brain will make the interface beautiful. The visceral level is one, out of three, level of brain processing. It manages our impulses and reflexes, such as choosing a ripe fruit instead of a rotten one, or prefer music to the sound of a power drill. The other two are the behavioural, and the reflective level. The behavioural level manages our behaviour such as walking, running or driving, and it is on this level we sense if a system follows learned conventions or not. The reflective level manages our ability to reflect on different impressions or prior experiences. At this level we can form a personal opinion about a system, whether we feel satisfaction or not, when using the system.
4.2 Learning

As mentioned earlier, learning will be the focus in this thesis, or rather, trying to build a training-platform that supports learning. If the users have not gained any new insight and understanding on the subject when they are leaving the application, the education might as well have been conducted in a traditional way, in a classroom with a teacher present.

The question is; how do we create a training application to support learning the best way? The usability aspect is already covered, but what tools and support does it have to include?

There are several theories on how students can reach a high level of comprehension. One popular classification is Bloom’s Taxonomy. Benjamin Bloom, an educational psychologist at the University of Chicago, constructed, in 1956, his classification to categorize different levels of abstraction in the learning process, to help students develop their abilities to acquire, process and evaluate information. Revised and rewritten over the years, Bloom’s taxonomy divides educational objectives into three different areas, or domains. The domains are: Affective, Psychomotor and Cognitive.

• **Affective**
  The affective domain deals with skills concerning students’ personal relationships and value systems, like the ability to emotionally sense, or feel someone else’s hardship or happiness. The affective goal is to become more aware and develop, ones attitude, emotions and feelings. Consists of five levels.

• **Psychomotor**
  Skills in this domain focus on the ability to perform tasks, or to manipulate a physical object such as an instrument or a tool. The objectives aim is to change, or develop, behaviours or skills.

• **Cognitive**
  In the cognitive domain, skills of knowledge, comprehension and critical thinking of a topic are of importance. Traditional education tends to signify skills in this domain. This domain consists of six levels.

It is important to cover all three domains to get an overall view, and form, of the education.
Following the psychomotor domain is exactly what the ambulance education has done thus far: Enhancing the physical skill in manoeuvring the tool, the tool being an ambulance. This has been done in exercises of maintaining control over the vehicle on slippery roads etc.

The questions (found in appendix C) relates to training in the cognitive domain. There are six levels in the taxonomy in the cognitive domain, and as in the other taxonomies, it is hierarchical in that one has to master the former level to proceed to higher levels.

1. **Knowledge**
   The students demonstrate that they can reproduce factual knowledge, which they have memorized.

2. **Comprehension**
   Students show that they understand the relationships and correlations in the material they have learned.

3. **Application**
   The students can apply their knowledge to new, to them relatively unknown, fields.

4. **Analysis**
   Students can analyze the components of a whole and find the key parts.

5. **Synthesis**
   Students can compile information together and produce alternative solutions by combining parts in new patterns.

6. **Evaluation**
   The students are able to evaluate ideas, knowledge, techniques and solutions (present and defend their own qualified opinions).

Prior to this project, some levels might already have been obtained, how many depending on whether the driver is already experienced, or has just recently begun working as an ambulance driver. During the initial lessons the drivers will answer questions that primarily target the higher levels in the cognitive taxonomy. Questions like: -Reflect on current conditions and how it affects your driving. -Make an assessment of relevant risks in the situation and –If the speed is increased/decreased, how are the risks increased/reduced, and why? Now, two domains are covered, the psychomotor and the cognitive. The affective domain is however not yet examined. The affective taxonomy has five levels:
Receiving  Responding  Valuing  Organization  Characterization.

Each level has to do with feelings, beliefs and opinions etc. from Receiving, which is the lowest level, were the student merely pays attention, up to the Characterizing level which, when reached, will assign values, or beliefs, that will colour the students behaviour and become a characteristic.

Whether it is about becoming an expert in a specific topic, by accumulate, or add, higher levels of understanding (cognitive domain), or finding it meaningful or fascinating to participate and study such a topic (Affective domain), the question remains on how one proceeds to organise a computer mediated educational platform so that the levels in the taxonomies can be reached?

The first three or four levels in the cognitive domain are straightforward in that it allows the student (ambulance driver) to reach them without really having gained any new knowledge. This, and several issues regarding the affective domain, is discussed in Cognitive Tools for Learning (Broberg 1997).

Broberg writes about the TIPS-project, an early seventies project with the aim of describing and affect study skills. The book makes a distinction between two different ways of acquiring new knowledge, or levels of processing. Some students use one way of processing a text (“text” being any type of presentation of information, written, spoken, video etc.) called surface directed. The surface directed way of processing a text gives a shallower understanding of the text as oppose to depth directed style of processing. Depth directed style is closely related to the affective domain, and is the preferred way of studying when trying to advance to a higher level in the taxonomy.

When measuring the knowledge gained or level of outcome, the depth directed way is superior to the surface directed. The study technique of the surface-, contra the depth-students differs in the usage of the text. Students, which use the depth-directed style, are using the text more actively. They engage in a dialogue with the text, asking themselves questions about the meaning of the text, which they can relate to their own characteristics and knowledge formerly acquired. The researchers in the TIPS-project then tried to alter the surface directed students way of processing by preparing the texts with processing questions. A kind of artificial depth directed studying. The students however, instead of devoting themselves to the
text, adapted their surface directed processing by skipping to the questions first, and then quickly review the text only to look for the answers. It was soon figured out that the depth directed students was more motivated than the surface directed students. Another experiment showed that surface directed students are also motivated, but their motivation has to do with external factors.

*External* motivation is motivation set by outer conditions and circumstances. The motivation to get a new job, making your parents proud or pass an exam, are all external factors for motivation. *Internal* motivation, on the other hand, is the kind that the depth directed students’ posses. Personal interests or the enjoyment in studying a specific topic, are typical internal factors. Another important issue, influencing the processing style, is the *relevance* of the content of the text. Like motivation, relevance can also be divided into external and internal. External, for connecting the content with factors beyond ones own control, and internal, for connecting the content to own personal understandings of the text. Not surprising, feeling internal relevance tend to affect the processing towards a depth directed style, and external to a surface directed style.

There is yet one more type of relevance: *Substituted* relevance. Substituted relevance depends neither on personal factors, nor is it dependant on external circumstances. Substituted relevance has much to do with the performance of the teacher. Things like interesting examples, illustrations and enthusiasm, can make students experience substituted relevance, which in turn will (hopefully) trigger their internal relevance. These results, together with other information science research, the book gives a suggestion on a model for learning.

Broberg uses several key concepts to describe the theoretical basis for a computer-based learning environment, some of which are presented below.

- **Knowledge workers**
  Use the phenomenological approach to learning so that the learners’ situation resembles that of a scientist, who is driven by internal factors of motivation and relevance in his work, and is also working in a goal-oriented process.

- **Understanding**
  In philosophy two different kinds of knowledge exists, *knowing that* and, *knowing how*. In cognitive science the same are labelled Declarative and Procedural knowledge. Declarative knowledge is knowledge of facts; who, when, what and so on.
Procedural knowledge is knowledge on how to perform a process. Both declarative and procedural knowledge can be graded on a quantitative basis. –*Name as many car parts as you can.* Or -*Repair the car as fast as you can.* The book speaks about a third, and perhaps more important, kind of knowledge, *Knowing why.* This has to do with understanding a phenomenon. The example below explains the difference.

**Knowing that:** Knowing that the right-hand traffic shift took place in Sweden in 1967.

**Knowing why:** Understanding why the preceding referendum was won and what consequences it had on the people, and what benefits/drawbacks it had in the long run.

When this is established, a transition from a quantitative approach of judging knowledge to a qualitative approach becomes necessary. The model shall support reproduction of the text only if one understands the meaning of the text - promote depth directed processing.

- **Learning is a generative process**
  Learning is a step-by-step process and new knowledge shall preferable have its origin, or basis, in knowledge already known.

- **Confirmation**
  It is important for users to confirm knowledge learned so far, to get an idea of ones strengths and weaknesses. In traditional education, exams are used for confirmation of the learners’ state of knowledge. More effective is self-assessments that the student has more control over.

- **Active learners**
  Actively process, search and retrieve information. Set up goals and pursue them. This is possible in that the environment (system) encourages learners to be motivated by internal factors.

- **Communicate**
  Promote a non-competitive setting. Learners learn from each other as well as educators.

- **Navigation**
  Design tools to support users in their decision making of where to go next.

- **Orientation**
Knowing what one knows, or don’t know. Also knowing how much others know. If one is conscious of his/her own state of knowledge, one can make better decisions on where to go next.

- **Focus**
  In a non-traditional learning system like web-based education, focus plays a major role. Learners studying in an environment based on exploring and information searching has to get the proper support to maintain focus. Without the support the outcome can get low.

These ideas reappear in the authors’ Ph. D. thesis: *Tools for learners as knowledge workers* (2000). The tools discussed are a more detailed review of the concepts above.

Here, seven kinds of support, for high-level tasks in computer-based learning environments, are mentioned. *Establishing and maintaining focus, Active learning/reading, Communicating the learning process, Bridging distances, Confirming the state of knowledge, Managing the information overload, and Finding internal factors of relevance and motivation.*

**Establishing and maintaining focus**

The process of establishing focus fluctuates between widening and narrowing the area of interest. In the widening phase, a large amount of information on the topic is gathered. In the narrowing phase the information is filtered and the essence is found. In the next widening phase, information about the essence in the former phase is gathered, and so on. For this process to work, proper tools for exploring the topic must exist.

During this learning process, when drifting between the widening and narrowing phases, the problem of *maintaining* focus can arise. If the information resources (in which you explore the topic) are vast, some way of handling the information overload must be available.

**Active learning/reading**

To actively read and process the material in a manifold of ways will give the user a deeper understanding of it. Active reading is achieved using practices like; editing, extracting meta-information, processing meta-information, making changes in the structure, making notations, searching for information, assessing one’s state of knowledge, communicating the way one has processed the topic etc.
Communicating the learning process

Communication between users is of great importance. One way of doing this is to let the users annotate the material. These annotations can serve as reminders to oneself, but also to advice other users. When a user is looking at some instance of the material, the user should have the possibility of choosing among different “versions” of that instance. Or to choose a cumulative version containing all annotations, or changes, made by all users.

Bridging distances

The biggest advantage with computer mediated learning environments, and especially web based, is the bridging of distance in time and space. One can choose to use it at any time of the day, for how long as one want, almost anywhere in the world. The language aspect is yet another barrier that can be solved by having different language files to support international users. However, there are other distances in learning. Unlike a textbook, which can be processed in a rather limited way, a computer mediated learning environment shall support different kinds of users, with different ways of processing. According to Kolb’s learning style inventory (Kolb 1979), four different types of learners exist. The converger, accommodator, assimilator and the diverger.

The converger is analytic, rational and uses logical thinking to solve tasks. The converger prefers a controlled, supervised teaching and their key question is How?

The accommodator is active and action-oriented. He/she wants to work practically with concrete tasks and often find new ways to apply newly acquired skills. The accommodator likes to experiment and learns by trial and error. Key question is If?

The assimilator wants to know theories and facts. He/she listens to experts and conducts own research, will rather be alone than work in groups. The assimilator prefers to read a manual rather than trial and error. Key question: What (is important)?

The diverger wants a personal and emotional connection to the subject, and also wants to know why he/she is supposed to learn about it. The diverger learns through experience and prefers practical assignments, or role-play, in groups rather than individual work. The key question is Why?
Proper support for all of these different learning types must exist, and different ways for them to address the material must also be available.

**Confirming the state of knowledge**

Broberg mentions three ways to support users to confirm the state of knowledge they are in: Discussion, assessments and visualisation. Discussions between users are a great way of getting a sense on how others have processed the material, but also how far they have advanced. Assessments are the traditional way of confirming what has been learned, in the form of written tests. The system should let the users make self-assessments, which are based on the knowledge worker approach. The visualisation aspect can be compared with a to do-list. Once you have achieved some item on the list, that item is marked as finished (checked). The same applies to learning. To mirror the learners state of knowledge, facilities that resembles the to do-list should be offered by the system. Subject areas already known, assignments completed, assignments started, documents unread and statistics about how many times a certain piece of information (document, website, video, sound etc.) has been used, are all examples that help, or mirror, the users state of knowledge.

**Managing the information overload**

In systems where new information accumulates at a fast rate, the need of some filtration is necessary. Breadcrumb trails, backlogging, meta-information and mechanism for filtering the in-stream of information are all examples on how to reduce the burden from the user.

**Finding internal factors of relevance and motivation**

A well designed learning environment which encourages the user to an active style of learning and will provide all support listed above (focus, communicating/confirming state of knowledge, bridge distance etc.) will make the user experience internal factors of relevance and motivation.

These key concepts will be used as a part of the overall evaluation of the application created.
SUMMARY 4.2

The support needed for the learners in their learning process has to contain certain tools. The tools that has been discussed in this chapter is issues that has traditionally been handled by a teacher or some similar supervisor. In a web application however, where the user alone conducts the work, all of these guiding, supervising and administrative matters has to be included in the application. Thus, the application should not solely present the data for the user. It should also support the user in making the right decisions. The application should guide the user so that the user can establish and maintain focus on what is essential. The users should be able to alter the material to fit them best. If users can write annotations, edit the material, or in other ways make changes to the structure, the environment supports active reading/learning. Communication between users is also important. The application should support a collaborative atmosphere, where users can engage in dialogue via the application. This way the users teach each other as well as communicate their way of processing the material. How they have worked, or are working, with some part of the material, what goals they have and so on. Some way of confirming the current state of knowledge is also necessary, as well as some way of keeping the information flow at a manageable level. Altogether, one should provide an environment where the learners are actively working on the topic with the proper tools, tools that suits the learner best, flexible tools that suits many different types of learners, and that all learners are feeling internal factors of relevance and motivation.
5. Testing, and usability improvements

This chapter will begin by analysing the intended users of the application. It will also describe the user-tests that have been conducted. Following these tests, some ambiguities became evident, and some suggestions on how to solve these issues has been addressed in section 5.3

5.1 User group

Who are the users? Are their any cultural differences between them, what is their experience in similar applications, what computer skills do they have and so on? These types of issues are often relieved with standardised symbols and language. However, a close inspection on how the user group is composed often leads to better usability in the end (Hult, n.d.).

This particular user group, the ambulance drivers, consists of 50 people aged from 27 to 62, with an average age of 42. Gender wise there are 11 female and 39 males and they all share the same nationality, Swedish. No previous computer-assisted training has been available in the driver education thus far, but those who recently carried out their nurse education might have had some items or courses where computers were used. Individually, the computer skills are as expected when trying to categorize a somewhat heterogeneous part of society. Some have difficulties opening a browser while others might have taken a few courses in computer science. Some user testing has been done and it also showed that the computer experience differed widely.

The characteristics stated above tell us about the users abilities. We can also assume that none of the drivers have motor, visual or auditory disabilities; hence there are no requirements on the application to supply any specific aid or support. To survey a user’s ability is pretty straightforward. It is just a matter of gathering as much information on that user as possible. The motivation and behaviour of the users is a more complex task to ascertain, but can be attained by conducting user tests.

5.2 User testing

Once the prototype was ready, some tests were conducted. The users were told to execute different tasks while answering questions. The instructions, and questions asked, are available in appendix B. This section will cover the parts in which the users provided interesting information. The immediate feedback was the lack of conventions. When logging in, the marker has to be placed, by the user, in the username text field. Many users were accustomed
to start writing as soon as the page had loaded, and did so only to find that no text had been entered in the field. Once the username and password had been entered properly the next convention broken, became apparent. It is customary to hit the return key, following a login. In this application however, that, minor but important feature, have not yet been implemented. One has to manually click the Login button, or press the tab key until the button is enabled and then press the return key. This is also the case with the Choose button when choosing what emergency-run one wish to observe. Another request from some users was to alter the drive lists to have more of a popup style. As the runs accumulate the lists can get quite large, and scrolling through them can be time consuming. With the popup model the labour is reduced to one click and then drag the mouse. The runs are sorted by date and time. The users would rather have had them sorted by the address of the accident, plus date and time, or at least, the area, or region where the accident occurred. Many wanted the possibility to see which ambulance was used in their chosen run.

When choosing a specific run, that run is loaded and the recording of the run is visible. Some of the users had trouble moving around the video-window on the screen, and had also trouble noticing the resize area in the bottom left corner of the video-window. The pre-made video control buttons were misleading to some. The volume slider has no function as the recordings lack sound. Nevertheless, many users tried to increase the volume, as they could not hear anything. The “Full screen” button is not working the way it is supposed, and when pressed the entire GUI goes into full screen mode, not the video-window.

Unlike the video control buttons, the buttons for speedometer, speed limit and g-force were easy to comprehend, but some users had difficulties interpreting the Activate/Inactivate follow route button. This button centres the vehicle representation (dot) on the screen. If it is turned off, the possibility of grabbing the map and moving it around exists. Some translated it as if the whole map would disappear if they were to press the button. Many users also preferred information in their native language. As a direct consequence of this, the language was changed from English to Swedish. The new labels can be seen on picture 9 below.

![Picture 9. Labels changed to Swedish. All of the G-force axis has also been added.](image-url)
The speedometer and speed limit sign was easy to understand and everybody expected the speed limit sign to update (if a new speed restriction area was entered), which it does. The G force graph was harder to grasp. The users could not see the linkage to the rest of the data. Most users wanted some feedback on what position in the graph corresponded to the recording. No one discovered the interactive points in the graph either. When a point is clicked, the video recording will skip to that position, and display the moment of the chosen g-force value. The plotted route was not obviously clickable to most users, and the possibility of operating the video from it had not occurred to them.

Most of what is observed during the user-study has to do with the behavioural level in the brain, and much of it concerns cultural constraints. Some visceral issues like the movable, or floating windows has also been detected, but what all the feedback has in common is that it revolves around the shallower aspects of the overall design. The next section will begin with some suggestions on how to solve these issues. Chapter 6 will then continue to discuss the deeper, more advanced questions about learning.
5.3 Improvements

This section will cover the immediate changes needed, which have been detected during user testing. This may seem like trifling errors at first, but will have a large impact on the user’s satisfaction towards the application, in the end. A comparison between the user outcome and Normans 4 design principles has been done.

Follow conventions

According to the user test, some conventions, or cultural constraints, has not been followed. The login issues described above has to be altered in a way that supports conventional usage. When the start page is finished loading the cursor should already be in the login text field, without having to place it there manually. Next, when text is inserted in the password field the login button should become enabled so that pressing the return key executes the login. Similarly, when choosing a specific run in the drive list, double-clicking a run should be supported.

Use words

The use of proper words for actions is important, as seen with the “Activate/Inactivate follow route”-button. Perhaps the difficulty in interpreting this had to do with unsuitable choice of word rather than the user’s proficiency in understanding English language. Either way, changing the language from English to Swedish solved this. If this application is to be used by others than Swedish-speaking users, one has to incorporate different language files and perhaps images for the buttons, which is promoted by Norman’s principle; both word and graphics.
Use metaphor

A lot of metaphors can be found in this application. The speed limit sign and the speedometer are analogous to their physical counterparts, and most users easily understood these features. The G force meter has to be modified so that it is synchronised with the rest of the data (map animation and recording). One way of doing this is to let a marker travel perpendicular to the time-axis in the chart, so the g force value dots gets more clearly linked to a specific point of time. Even more distinct is to shade the section of the chart, which the marker already has passed.

Coherent conceptual model

A consistent feature is that all windows can be moved around the screen. This is however not entirely obvious when using the application for the first time, and a way to make this more distinct is to place a so-called “drop-shadow” on all windows. This would enhance the impression that the window was hovering, or floating over the background (map). In the example below, window A has a more static layout than window B, which feels more movable because of the drop shadow effect.
6. Development of learning environment

This chapter will start with examining the existing system to see whether any of the support from chapter 4.2 (Brobergs’ tools) already exists. If the support is insignificant or missing, the next step is to improve the system to contain the proper support. If chapter 5 aimed to solve the appearance, user friendliness or the users first impression of the functions, this chapter is meant to analyse and discuss the support needed to improve the learning process once the users master the immediate features of the application.

6.1 Tools for learners as knowledge workers

These specific tools, from chapter 4, that are to be incorporated in the application, will at first be evaluated to what extend they already exist or not. These subsections will be labelled E.S, for Existing Support. Then, some suggestions on how to enhance the existence of the tools will follow. The suggestions will be labelled P.S, for Prospective Support, and will be written in bold, to easily distinguish them from the existing support.

6.1.1 Establishing and maintaining focus

Establish focus

The process of establishing focus fluctuates between widening and narrowing the area of interest. In the widening phase, a large amount of information on the topic is gathered. In the narrowing phase the information is filtered and the essence is found. In the next widening phase, information about the essence in the former phase is gathered, and so on. For this process to work, proper tools for exploring the topic must exist.
Tools for exploring the topic

• Choosing

E.S  Choose between personal, and other drivers’ emergencies. See how others have managed different situations, and then comparing it to ones own driving behaviour in similar situations, if a similar recording can be found. Choose the date and time of the preferred emergency run.

P.S  Choose between your own, and other drivers’ emergencies. See how others have managed a particular situation, and then comparing it to ones’ own behaviour in the same situation. This requires an enhancement of the search function, with more criteria. The ability to sort the emergency runs by various meta-information must be possible. Meta-information such as: route, starting point/destination, backlight or similar distractions, what state the road is in (ice, snow) etc.
My suggestion is to provide all emergency runs with different tags. The runs can be labelled with tags like; slippery, dry, clear view, foggy, dawn, dusk, night, game on road, patient in vehicle, highway, dirt road, one way street, exceeding speed limit and so on. The same run should be able to hold several tags, as several things might characterize one emergency.
• **Recording**
  
  E.S The possibility to freeze frame to search the surroundings (around the vehicle) more easily, or to get a better overview exist.  
  Fast forward and rewind to skip some sequence of footage, or to watch it again.  
  
  P.S The possibility of watching two, or more, different recordings next to each others would allow the user to analyze and compare different instances of the emergencies in a natural way without having to load two recordings in a sequence. This could be done by a split-screen option similar to a two-player game mode, found in many computer games.  

• **Interactive map**
  
  E.S See where the vehicle is, which road, which part of town etc.  
  Skip to specific points in the run where interesting traffic situations may occur i.e. sharp corners, traffic lights, the busiest streets etc.  
  
  P.S Instead of the blue line of dots, the colours of the ambulance route can show whether the speed limit is broken or not. Green dots for distances containing velocities within the speed limit, and red dots for distances where the limit is broken.
• Speedometer G force-meter & Speed limit sign
  E.S See whether, or when, the vehicle breaks the speed limit, can one detect any
  patterns, trends etc.
  See how hard or fast, in terms of force, one drives in curves and on uneven
  roads. Also, the force in abrupt deceleration or rapid acceleration can be
  observed.

  P.S If the assignment is to make an assessment of the velocity at an overtaking,
  for example, the support for this should be to highlight the speedometer to
  guide the users’ focus to the right place. The speedometer and speed limit
  sign should preferable be integrated. Whenever the speedometer exceeds
  the speed limit, the user should be notified of this. The G force graph
  should also light up, in the same manner as the speedometer, whenever a
  critical value is reached.

Maintaining focus

E.S During the learning process when drifting between the widening and narrowing
phases, the problem of maintaining focus can arise. If the information resources
(in which you explore the topic) are vast, some way of handling the information
overload must be available.

P.S The application should save the state of the user so that the user can
continue where he/she left off, and also give the user a brief review of the
previous session.
6.1.2 Active learning/reading

The system should offer the users to process the material in many different ways. The need of tools to facilitate this way of learning must exist. The tools must support the activities listed below.

- Editing
  
  **E.S** No editing capabilities exist to date, except changing the number of features visible at a time.

  **P.S** It is important that the editing capabilities are many. However, if users can alter too much, the labour involved in editing may steal the focus from the primary task. Simple additional editing options can easily go from being a help function to being a primary task. Because of this, the editing capabilities should increase, as the user gets more and more familiar with the application. This can be done by monitor login-frequency or counting the time spent with the application. It can also be done manually, so that a user can choose for him/herself what level of editing he/she prefers when launching the application.

- Extracting meta-info
  
  **E.S** Users can see for how long an emergency has lasted. This is helpful if a certain turnout, such as a highway (drawn-out) or an inner city emergency (brief), is sought.

  **P.S** See section *Tools for exploring the topic under Establishing and maintaining focus* above.
• **Processing meta-info**
  
  E.S There is at present, no way of processing, or alter meta-information for a user.

  
  P.S If the users are able to tag their runs, and assign different features to the runs, the labour of searching is reduced.

• **Making changes in the structure**
  
  E.S The possibility to choose which kind of data that should be visible, and how it should be presented exists. Some users might find it annoying to have many focus points at the same time, hence this option.

  
  P.S As mentioned before, the possibilities of watching two or more videos simultaneous, or side-by-side would allow the user to compare different drivers driving the same route, same driver, different route or perhaps different weather conditions. Whatever the reason might be, this option could be very useful.

• **Making notations**
  
  E.S It is of course possible to leave a post-it note to another user and suggest specific runs for this user to watch, but it is not so effective, and has little to do with the system.

  
  P.S See activity “Communicating the way one has processed the topic” below.

• **Searching for information**
  
  E.S Scrolling through lists sorted by date and time. Jump to certain points in the G-force graph where a particularly high, or low, value has been observed.

  
  P.S For some type of learners, described in the *bridging distances* section below, the ability of searching for additional information is important. Links to pages containing this information should be available. Again, this should be optional, and the possibility to disable this feature should exist.
• **Assessing one’s state of knowledge**
  
  **E.S** To see how well one performs in the actual recordings is a good way to estimate the state of knowledge.

  **P.S** Every run should contain self-assessment questions. Presently, a supervisor asks the questions. Questions like the ones found in appendix C might as well be lifted into the application.

• **Communicating the way one has processed the topic**

  **E.S** Discuss with other users, which style of processing that has been used. Whether all features was used or only some i.e. only video, video and map etc.

  **P.S** Users can mark interesting areas along the route where some event or incident has occurred. This could be done with pushpins or other map markers, preferable with different colours that tell what kind of incident is marked e.g. accident, overtaking, traffic light and so on. A text box with further information should also appear when the cursor is above it. The next user to watch the run will then know immediately where to focus. This facilitates the activity of *Making notations* listed above.
6.1.3 Communicating the learning process

E.S
In the initial stage of this project, the system has been used with a supervisor present and the lectures have been summarized with discussions in group-sessions after completed test course.

P.S
It is important to share reflections, suggestions and useful hints, to other users. This should be done with annotations. A user can make an annotation, during a specific run. This annotation can later be visible for other users if they choose to attach it when loading the run. And with this, a user has the possibility to watch the same run but with several different annotations.

6.1.4 Bridging distances

E.S
Space: The learning environment is not tied to a specific location, but is accessible from (almost) any computer with an Internet connection.

Time: The environment is accessible at any time of the day, and can either be utilized for hours, or brief moments, as one wishes.

P.S
To bridge the distance between different kinds of users is also important. To handle different type of learners requires a different structure to the questions and the actions. Below are some suggestions on how to facilitate for Kolb’s four different styles of learners.

- Accommodators:
  As the accommodator prefers a role-playing learning situation to a more traditional lecture based, it should be possible to process the runs in a manner similar to a game. In a game one has to select between a number of paths, doors, items or something else where the outcome is uncertain. The outcome can
however be calculated depending on how much information we have regarding this specific situation. If we have experienced the situation before, we have a great advantage. If we have not, the surroundings (sounds, fire etc.) will give us information to form a decision. If we have made the right choice, based on our knowledge on the situation, the outcome should be successful. The same can be applied on our application. If it is possible to watch similar videos side-by-side, as mentioned earlier, the accommodator can pause and analyse the surroundings and all data that can matter in the traffic situations. He/she will then be able to estimate which situation will be most favourable, and can confirm his/hers choice just by finishing watching the videos.

- **Divergers:**
  
  This type of learning platform suits the diverger well. The diverger learns most by observing, which is the main function in this project. The diverger also learns by discussing the subject in-group, preferable with others sharing the same learning style. For these learners to gain insight, the application should have some sort of discussion forum.

- **Convergers:**
  
  The converger wants structure and a directed learning situation, where there is a single right answer. However, self-studies also fit the converger, as it allows him/her to actively seek knowledge. For this application to suit the converger, there should exist a way of processing the runs in a predetermined manner, so that it mimics a traditional teacher-student situation. The application can guide the student along the session on what to do, where to go next and so on. Links should also be incorporated. It should be possible to get more information on aspects concerning the subject. Links to facts like; withstanding g-force, tire pressure and hydroplaning, night vision and age etc. should be available.

- **Assimilators:**
  
  Assimilators prefer to get a detailed background on the subject. The assimilator learns through lectures, reading manuals, reviews, expert opinions and own research. When the facts are established, the assimilator has a good basis of theories to apply when creating models of reality, or theoretical models. Thus, the
assimilator gets good at providing underlying reasons why a certain situation occurs, or why some problem exists. It would be beneficial to the assimilators, if the application could supply a library of essential facts. Once the theoretical is learned, they should observe traffic situations where mistakes are made, and answer questions on how, and why the mistakes are made.

6.1.5 Confirming the state of knowledge

E.S The tutor can grade a user in person or in writing, but not in-app.

P.S Users should be able to discuss their learning experience with other users. This can be read about in section 6.1.7 Finding internal factors of relevance, and motivation. Another way of supporting users to confirm the state of knowledge they are in is visualisation. To visually show the user which parts or sections of the application he/she already has achieved will prevent that user from doing things twice.

6.1.6 Managing the information overload

E.S The emergency-runs are sorted by driver name, and what date/time the emergency took place.

P.S Let users gather the runs that best coincide with their ambitions, difficulties or other preference, possible tied to their profile. This collection of emergency runs will resemble speed dial numbers on a telephone or “favourites” in a music library i.e. playlist.
6.1.7 Finding internal factors of relevance, and motivation.

E.S To watch recordings of oneself driving the ambulance, should trigger a kind of internal relevance and motivation. Relevance because it is all about you, and no one else, and motivation because the user wants to perform well and improve, at least it is my opinion that nobody prefers failure to success.

E.S If all of the support, listed in this chapter, can be met, internal factors of relevance and motivation will automatically follow. However, this type of desired support can be further enhanced by letting the users get different roles, and as they grow more secure in using the system their roles will evolve from being students to becoming mentors. When a user first starts using the application he/she will be given the role of the student. As the user learns more about the system, the user can start guide other students, hence becoming a mentor.

<table>
<thead>
<tr>
<th>Student</th>
<th>Mentor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided</td>
<td>Guides</td>
</tr>
<tr>
<td>Passive</td>
<td>Active</td>
</tr>
</tbody>
</table>

SUMMARY 6

If the users get different roles of students and mentors, mentioned above (6.1.7), all of the support declared for in this chapter would be facilitated in that the students and mentors communicates and motivates each other. The mentor will also help the student to maintain focus as well as assess and confirming the students’ state of knowledge. This will make the system into a community where active learning is promoted. Some users might not be interested in participating in such a community, and can of course use the application without the guidance from mentors. But all the other enhancements suggested in this chapter, would probably form an educational environment that meets the demands and findings from chapter 4.
7. Conclusion

This projects’ aim was to enhance a learning application to include support that will aid the user in making the right choices, keeping focus, find it meaningful to use the application, and of course, get the most (new knowledge) out of the learning experience. The enhancements have not been implemented though. This is because the application had to be built in the first place, and it was not enough time to implement all the new support, nor is it clear exactly how this new support should be implemented. This is something to focus on in future work, if this project progresses.

7.1 Limitations and restrictions

The technical specification and general requirements was done before I joined the project, and Caplan and Graham (2008) argue that if instructional material or media is to be created, the designers and developers of that media should be incorporated in the process from the very beginning. And as mentioned earlier, some of us developers became involved in the project after AKMC had already made a blueprint, and hence this directive was not followed.

The testing that has been taken place, have mostly been aimed at the users experience rather than formal software testing like finding bugs and so on. Tests with different browsers and operating systems have been done, but that is about it. If this application is to be used commercially, some large-scale testing is needed.

7.2 Reflections

Throughout this project a degree of optimism has characterized the work. An optimism of time, needed for the different elements to be completed. There were many parts in this project that took far more time than was anticipated. This is also why deeper contemplation and reasoning, before implementing, became hard to manage at times. In retrospect, this project has been much more extensive than I had imagined, and this is partly self-inflicted. Originally, the idea was just to make a proof of concept, but as the project progressed, and the desire to do well existed, the application got increasingly more complete. But even if too much time was spent on doing the practical work, the experience has been very valuable.
Overall, this application is a first working prototype, and meets the most crucial requirements, and even though some issues have been hard to solve, I am satisfied with the result.
8. Acknowledgements
I would like to thank the following persons for their help in achieving this final degree project. First of all, Fält communication staff, for having facilitated my work in different ways. Some of these persons in particular deserve special attention: Patrick Persson has been an excellent external supervisor, and has given me a lot of help in several areas. Henrik Sandberg has been my partner in implementing the application. Without him the work would have been protracted if not difficult to achieve at all. Björn Kriström is the developer that has built and administrated the database. He is also guilty of helping out in numerous ways. Thomas Lundgren, who has been the project manager, has been full of ideas that have been incorporated in the application. And of course CEO Mikael Långström for providing office space with the necessary computer equipment as well as valuable insight in the IT line of business.

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Anders Broberg at the University of Umeå, has not only been my internal supervisor, but has also had another leading role in the project. Not only did he introduce the project to me, but also introduced Fält Communications to AKMC. Anders have supported and provided me with literature as well as other important feedback.

-Many thanks to all of you, and to anyone I might have forgotten.
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Appendix A.

Application Specification from Fält Communications (In Swedish)

Utvecklingsuppdrag:
Ta fram en web applikation för presentation och analys av inspelade körsträckor vid blåljuskörning med ambulans.

Inspelning av följande data kommer att göras synkroniserade med tidskod: MP4V Video, NMEA data från GPS, accelerationsdata från G-sensor, bromsindikation (ev. ABS), RFID indikation från vem som kört. Inspelning och överföring till filserver/databas ingår ej i examensarbete och kommer att implementeras av annan part.

Följande funktioner skall implementeras:

- Säker access, individuell inloggning för presentation av enbart förarens körningar (hanteras mha RFID data)
- Adminstrationssida för hantering av konton och access
- Presentation av tillgängliga körningar för valt konto och möjlighet till sortering och sökning bland dessa.
- Möjlighet skall finnas att namge en körning samt mata in tilläggsinformation för en körning (valfri text)
- Vald körning skall presenteras i form av karta, videofilm, och övrig data som är G-Sensor, broms/ABS, hastighet, ISA hastighetsöverträdelser. Ev. kan mer tilläggsdata komma till.
- Styrning av uppspelning skall i form av vanlig mediastyrning (start, stopp, framåt, bakåt) men även genom att man klickar i kartvyn på ett ställe i vald körning och då hoppar all presentation (video, sensordata etc) till denna tidpunkt i körningen.
- Tid (svensk och delta från start) och ackumulerad körsträcka presenteras id aktuell körtid.
- Hjälpfunktioner skall finnas inbyggd i web applikation.
Appendix B.

Instructions and questions asked during user observation.

Opening questions (Q)

• Previous computer experience?
• Age?
• Gender?

Instructions (I)

• Do not be afraid to make mistakes, this is an observation.
• Think aloud while you test the application.
• Perform the tasks.

Login screen
Q: What does the interface tell you? Are there any ambiguities? What information should you enter?
I: Login with your username and password.

Drive lists
Q: What does the interface tell you? How do you construe the two lists?
I: Select any given emergency run.

Main screen
Q: Where do you focus? Which part/parts of the application captures the eye?
What happens on the screen? What can you do with the video player?
I: Try to operate the video, play around.

Map
Q: Can the map be manipulated in some way? Can you zoom in and out? How do you do that? Can we change the map view to be shown in aerial view instead? Can you look at the map outside of the current ambulance route? What are the dots on the map? Is it easy to see where the ambulance is? Are the dots interactive?

Buttons
Q: What are the buttons for? Meaning? Are there ambiguity or alternative interpretations?
I: Try to find help and instructions. Then close the window.
Q: Was your first impressions consistent with the proper functions of the application? If so, which? Which functions were not consistent with your first impressions?
Speedometer
I: Make the speedometer visible.
Q: Is the speedometer clearly linked to the video? Are the meter readings easy or difficult to read? What do you do when the meter is obstructing the ambulance icon? Is there anything that indicates that the meter can be moved?
I: Place the meter in any position on the screen if not already done.

Speed limit sign
I: Display the Speed limit sign.
Q: Is it obvious that the sign is going to be updated, unlike a static image?
Do you feel that it is easy or difficult to keep track of the speedometer and the speed limit sign while at the same time watching the video?

G force graph
I: Display the G force graph.
Q: What information does the graph show us? Is the graph or the graph-window interactive in some way?
I: Skip to the point in the video where, you believe, the most intense cornering is made.

Plotted route
Q: What does the points on the map represent? Is it easy to see where the ambulance is? Are the points interactive?
I: Start the movie just before the end in any way you like.
Q: Can I do this in different ways?

Reflective questions
Affordance
Did the GUI offer sufficient information for analysing the emergency run?

Visibility of system status
Did it go to fast? Was there any appropriate feedback that told you what was going on?

Match between system and the real world
Was there any words or labels, hard to interpret? (technical terms instead of colloquial expression)

User control and freedom
Did you find an "emergency exit" to leave an unwanted state without having to reload the application? Was there support for “undo and redo”.

**Consistency and standards**
Was there different words, situations, or actions meaning the same thing (ambiguity)? Was conventions followed?

**Error prevention**
Was it possible to make errors (make the application freeze, or go into an infinite loop)?

**Recognition rather than recall**
Were objects, actions, and options visible? Did you have to remember information from one part (window) of the application to another? Was instructions for use of the system visible or easily retrievable whenever appropriate.

**Flexibility and efficiency of use**
Did you find any keyboard shortcuts for frequent actions, or any information about such?

**Aesthetic and minimalist design**
Did dialogues (help, error messages etc.) contain information which was irrelevant or rarely needed?

**Help users recognize, diagnose, and recover from errors**
Did the error messages express, in plain language (no codes), precisely the problem, and constructively suggested a solution?

**Help and documentation**
Was the help page easy to discover? Did it provide the proper help?
Appendix C.

**Protocol for AKMC lessons (in Swedish)**

Namn:……………………..

Ange datum och tid för körningen. ……………………

Korsning med rött ljus.

**Avsökning.**

Reflektera över aktuella förhållanden och hur det påverkar din körning när du närmar dig korsningen. (Exempel på förhållanden att reflektera över: Siktförhållanden i korsningen. Skymd sikt av andra fordon eller skyltar? Skymd sikt inne ambulansen av speglar, A-stolpe eller kollega?)

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**Riskbedömning.**

Gör en riskbedömning på relevanta risker i den aktuella situationen. (Exempel på risken att bedöma: År väghanen torr, våt, is eller snöbelagd? Hur blir stoppsträckan? Mörker? Oskyddade trafikanter?)

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**Hastighetsanpassning.**
Upphinnande

Avsökning.
Reflektera över aktuella förhållanden och hur det påverkar din körning när du närmar dig det framförvarande fordonet.

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Riskbedömning.

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Hastighetsanpassning

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Omkörningar

**Avsökning.**

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Riskbedömning.

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Hastighetsanpassning

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Appendix D

Graphic user interface. Screen shots.

D1. Interface as seen before any sensors-buttons has been pressed
D2. Speed, speed limit and G-force visible

D3. Enlarged video window.