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Mobile services for truck drivers

Therese Edlund
Samir Ciber
Göteborg, Sweden 2003

IT University of Göteborg
CHALMERS | GÖTEBORGS UNIVERSITET

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THERESE EDLUND
SAMIR CIBER

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Department of Applied Information Technology

IT University of Göteborg

Göteborg University and Chalmers University of Technology

P O Box 8718

SE – 402 75 Göteborg

Sweden

Telephone + 46 (0)31-772 4895

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THERESE EDLUND
SAMIR CIBER

Department of Some Subject or Applied Information Technology
IT UNIVERSITY OF GÖTEBORG
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Abstract

The thesis has been done at Volvo Technology Corp in Gothenburg and the goal was to discover interesting truck driver services that can be used in the truck driver profession. The services should be executed on a Personal Digital Assistant (PDA), related to the work done by the drivers when they are outside of the truck. A lot of theories have been used as a base for our study. All work has been carried out in correspondence with methods for the following areas; literature studies, field studies, analysis of problem areas, and design, implementation, and test of a software prototype on a PDA. When all literature studies, own conducted field studies, and some part of the analysis phase were completed, we had come up with a large number of ideas. All ideas were further analysed and of them were five services selected. These services are named: Load Indicator, Consignment Note, Drivers Manual, Friend Finder, Keyless entry and Alarm. Load Indicator is a service that helps the driver to keep track that the maximum cargo weight for the truck is not exceeded. Our Consignment Note, involves all handling of the notes in a digital form, i.e. no paper is needed. Drivers Manual is the digital version of the manual shown on the PDA. Friend Finder is a service that keeps track of a driver's colleagues and friends. Keyless entry includes services that handle automatic locking/unlocking of the truck door and automatic handling of the trucks spot and load lights. Finally, if the burglary attempt is made on the truck and an alarm is raised this alarm will also be shown on the PDA in the Alarm service. In the design of the above services, the end-users were in focus. The end-users are truck drivers usually not that familiar with computers (especially PDAs). Their work is also conducted, to a large extent, outside of the truck. Thus, our design is characterized with "usability" for that particular end-user group, with for example the use of large designed "Buttons" and the use of keystrokes on the PDA

Keywords: handhelds, mobile devices, PDA, design, truck drivers, mobile services, interface, GUI, load indicator, consignment note.

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1 Introduction

1.1 Background

The working life is more mobile than ever. Some professions are more mobile than others are, and the work is performed in different locations. For some professions, the work is executed "on the road" in a vehicle. All mobile workers use different kind of communication systems. In fact, mobile communication increases human interactions and by that, the isolation on the road will be broken (Spolander, 2001). On the other hand may the communication, while driving, jeopardise the safety on the roads. Distracting factors, such as mobile communication, can be devastating for the driver or other road-users, and leading to accidents (EcoMobility, 1997).

This study focuses on truck drivers, who are highly mobile and spend a considerable amount of time on the roads. According to Nehls (1999), a truck driver may spend many hours working in the truck cabin, of course depending on in which segment the truck driver works. Volvo Trucks Corporation defines three segments; long distance, distribution, and construction. Long distance is haulage between countries and continents, distribution is transportation between cities in a country, and construction is all transportation done for a construction site (usually short distance). Obviously, it is the truck drivers, in the long distance segment, that spends most time in the cabin. To be efficient, a driver needs to communicate with his home-office. Higher efficiency is reached if the communication is enhanced, both with more information, and with the use of new mobile communication devices. By enhancing the communication with real-time transportation plans and traffic information, the efficiency will increase (EcoMobility, 1997). It was not long time ago when all communications, between the driver and his home-office, only was done via a mobile phone. Today the driver does not even need the mobile phone to communicate. Information could nowadays, be communicated via computer systems that are installed in the truck. Many services are available to help the driver, like information of traffic situations, maps, guides, and entertainment, all, which can make the journey easier, and more comfortable (Ertico).

It should also be noted, that truck drivers conduct a lot of work outside of the actual truck, such as loading, and talking to customers etc. Such work has not yet been thoroughly exploited, hence we saw a good opportunity to further investigate it.

1.2 Frame the problem

The thesis will be done at Volvo Technology Corp in Gothenburg. The goal is to discover new innovative truck driver services that can be used in the truck driver profession. The task is to find the best services, executed on a PDA / Smartphone, which are related to the work done by the drivers when they are outside of the actual truck. The second goal in this study is to analyse the new defined services and make a good design to be implemented in a prototype.

The research question is: What kind of interesting services, used on a PDA by truck drivers in their profession, could be discovered, and how could they be designed?

2 Theory

In the theory part, we firstly talk about the mobile IT use and mobility. In the second part of the theory, we are explaining fundamentals of mobile devices and the belonging technologies. These technologies will be used to realise our ideas into a prototype for testing. Next, we

follow up with information of some existing transportation systems and needs for a better transportation systems. Some information is about what kind of services you can find today and what kind of technique we can find together with this in vehicles. Finally, the designing concepts are described to raise the problems, which appear when designing for different groups of users and when designing for small screens.

2.1 Mobile IT use and mobility

Fagrell H, (2000) claims in his study that the trend of mobile IT is part of an overall trend in society towards mobility. Today people are, thanks to new technology, more mobile than ever. If you compare today with ten years ago, you will find a major difference. He continues that the investments in technology to reduce travelling are higher that ever. An interesting issue he reveals is that mobility has largely so far been overlooked.

Kristoffersen and Ljungberg (1998) provide, in their study, designers with a framework of concepts allowing you to understand and discuss how people use IT in mobile settings. They also claim that this framework will help designers to invent new concepts and imagine new metaphors for mobile settings. It is important to understand the differences between using IT in mobile settings and using IT in stationary settings. The computer in the stationary setting offers you, compared to the mobile setting, a permanent, reliable and fast network connection, a big colour screen, a mouse, and a large keyboard placed on a flat surface.

Mobile phones and PDAs both support mobile work, but so far the PDAs have mainly been used as personal electronic calendars with a contact directory. A simple solution to enhance the PDA would be to give it access to existing mobile systems (Fagrell, 2000). Fagrell also states that when you for example meet a client in the field the PDA could be used to remind you of the latest interaction and the current agreement with this particular client. In such situation the PDA would preferably be connected to the mobile network in order to download the latest client data.

2.2 Mobile devices and Technologies

2.2.1 Mobile device

Mobile technologies and mobile devices allow geographically distributed activities to be organised. It has been a while since mobile devices were introduced although they are still in an early stage of their lifecycle. The development, however, progresses with an enormous speed and new mobile devices are introduced every month to the market (Greer). Greer continues that the biggest advantage with a mobile device is the fact that it is mobile i.e. you can bring it wherever you. Since the device will be with us all times, unlike a desktop computer, it will be used in a variety of social context.

The mobile device is usually a personal object, and personal information is stored on it. The owner of the device is the only one who has access to the information, which is and may be a key factor over time. With better services and even smaller size devices may be more popular than today. A mobile device will be even more useful if it can be enhanced with Internet connectivity, via for example WLAN or Bluetooth. With an Internet connection, you will have the possibility to send messages to you friends and to download information whenever you want and wherever you are. The information on your mobile device will therefore always be the “latest and greatest”.

An example of a mobile device is the Personal Digital Assistance (PDA), which so far is not a major success. Nevertheless a lot of new PDAs have recently entered the marketplace. PDAs are perfect to use when we you are mobile, e.g. driving or walking. They are however

generally too large to keep in a shirt or pants pocket, or in a wallet. The devices will probably be more utilised when they are small enough to carry around. The most common way to use it today is as a substitute for an ordinary calendar, i.e. the most frequent used functionality in the PDA is the calendar and the address book. Another example of a mobile device is the Smartphone that is a combination of an address book, electronic organiser, and a cell phone. This device is a digital wireless telephone that has the possibility to send and receive data i.e. the user has an Internet access and by that the possibility to send for example e-mail to their friends. There are, however, no guarantees that Smartphones or PDAs will be successful on the market especially not if there are not enough services available.

2.2.2 Mobile technologies

Wireless communication over IP

Bluetooth wireless specification ensures communication compatibility worldwide and the wireless technology allows you to bring connectivity with you. Bluetooth is an open specification for a cutting-edge technology that enables short-range wireless connections between desktop and laptop computers, personal digital assistants, mobile phones, printers, scanners, digital cameras and even home appliances — on a globally available band (2.4GHz) for worldwide compatibility. Bluetooth (802.15) and WLAN (802.11b) are complementary and many portable PCs include both. Bluetooth is by its nature not designed to carry heavy traffic loads. It is not suitable as a replacement to LAN-, WAN-, and Backbone cables. The emphasis in Bluetooth is on mobile, re-configurable computerized units that need sporadic contact with each other (Bluetooth.com).

If you have a mobile computer system in a vehicle, a driver has the possibility to physically dock a mobile device to that system. The driver will then in principle have the same possibility to influence the information, in the vehicle system, with his mobile device. Of course the same type of applications should be possible to run on the mobile devices as in the system in the vehicle (Spolander, 2001). The mobile communication device is connected to the computer system via for example Bluetooth.

Global Positioning System: GPS

A technique that can be very useful when users are mobile is the GPS system. With GPS the user can find out the exact geographical position, on the earth, he is located in. GPS will tell the user the exact position day as night regardless of the current meteorological situation.

2.3 Telematics

We can see that the efficiency of transports is more and more improved. This is not only important for the transportation itself, it is also very important for the environment. Hence, better and better transportation system is needed. Spolander (2001) says that the need of lower fuel consumption, increased trafficable roads, increased comfort, and safety is obvious. Information about carrying capacity, the height of the roof of a bridge or a tunnel is of vital importance for the stationary road network. Prognosis of the traffic load, traffic accidents, or theft that can change the planed route are also important information. According to Spolander, the manufactures of vehicles are concentrated in all kind of support for the drivers like for example something that helps the driver to avoiding collision with other drivers and warning if the driver is outside the traffic lane.

Information of traffic situations, maps, guides, and entertainment are downloaded to the vehicles to make the journey easier and more comfortable. Bluetooth holds the inside communication between the driver and the vehicle and between different devices in the vehicle. One example of a system is the Dynafleet Information System (DIS). Volvo Truck has developed this mobile information system together with its customers to make the

transportation with trucks more efficient and safe. DIS consists of hardware, software, and a system that is integrated at the office of the haulage contractor. The system has simplified the transportation plan due to that a fleet organising centre is able to see where the truck is located and about the load information of the truck (Ertico).

Professional truck drivers are not only inside the truck when conducting their work. Truck drivers frequently leave the truck to perform other work tasks. The frequency mainly depends on what segment they working in. Volvo Trucks Corporation defines three segments; long distance, distribution, and construction (fig 1). According to the figure, we can conclude that truck drivers, in the long distance segment, are the ones that spend most time in the cabin. In the other two segments, the truck drivers spend more time outside the truck in proportion to inside the truck. The support inside the truck, as we know now, is already developed but the support outside the truck is not developed at all.

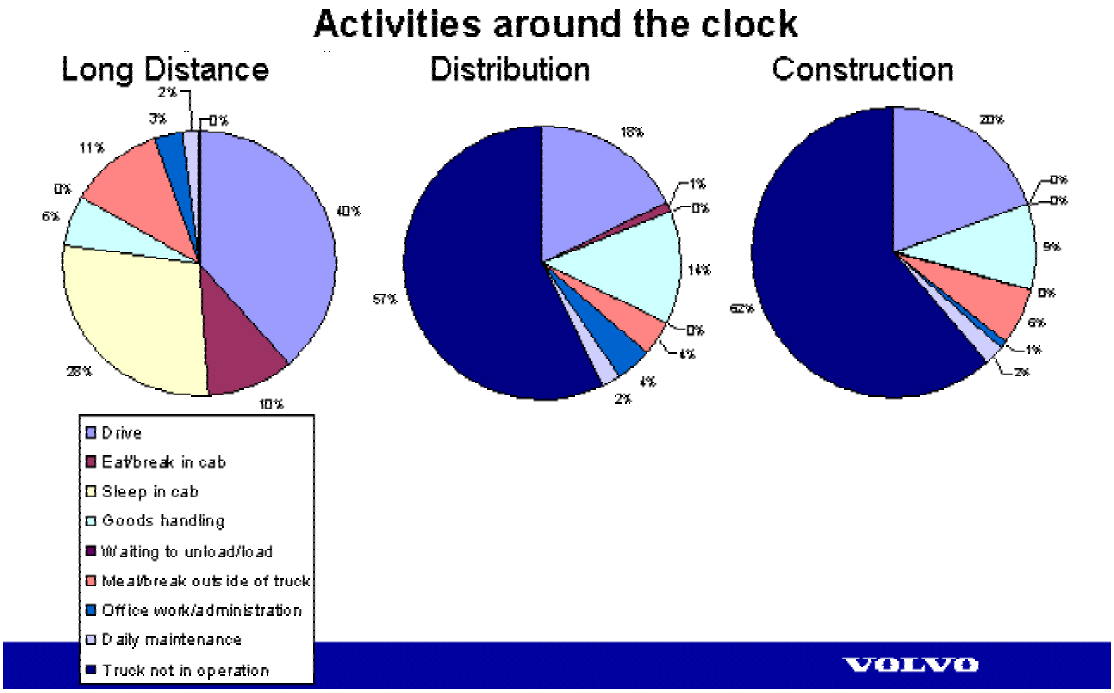

Figure 1: Activities when working in different segments. Volvo Trucks Co

2.4 Truck drivers and mobile devices

Nehls (1999) says that truck drivers are more and more directed to laws and rules in their working day and this depress the possibility to impulsiveness and spontaneity. Nevertheless, truck drivers view their work to be very “free”, and this freedom is an important factor. They also have a big responsibility to see that right goods on the right place in the right time are carried out (Nehls, 1999). With kind of statements in the study, you may concluded that truck drivers’ working day is more and more stressful and gives a sense of fatigue.

As mentioned before our main task is to explore services for tuck drivers when they are outside of the truck. The reason for this limitation is the fact that the currently most needed information is already presented by the trucks stationary systems and that additional services available when driving will further distracted the driving when driving.

With the computer system in the vehicle, truck drivers are able to download, for example roadmaps, via the network and then later on via Bluetooth to the mobile device. With

important information in the device, drivers will be able to access it also outside the truck, for example when having a break. Accessing information when not driving is of course safer but it may also decrease the stress factor. In peace and quiet, a driver could study the information and by that maybe avoid an accident.

According to Nehls (1999), a truck driver often feels alone when driving and the possibility to plan the trip to have a lunch with a friend can be encouraging and increase the social interaction. Because of this statement, a service that supports some kind of social interaction can be a good idea. This may also increase the awareness to take breaks, to decrease the possibility of an accident because of fatigue and less concentration. If the mobile device were personal, the driver would have all the personal information collected on one place irrespective of the fact which truck they are driving or what kind of system the truck is using. It is then good if the user knows how to download the information when he wants and understand the information. Spolander (2001) says that it an advantage that the driver not are tied to the truck to bring new incoming. The communication between the mobile device and the truck will be peer-to-peer when the mobile device is in coverage. Outside this coverage, there will be other techniques that supporting the services.

The interface for the mobile device has to contain services that are attractive to the user. The instructions for the services have to be easy to understand and have to be correct for the user so the services are easy to use (Spolander 2001). Together with the services, the design is important to prevent the truck drivers going back to paper formula again. To make a good design the designers have to think about the usability of the product, that the product is easy to use.

2.5 Designing for usability

The products that we use in our homes and at work are becoming ever more complex in terms of the features and functionality. It is important that the producers of products think that there are end users for the product. Nowadays, users do not tolerate difficulties when using a product.

We normally think about the consumer when we are talking about the adaptability and the reaction to the product. We can also see the human being in other rolls not only as a consumer. To make a perfect product, we have to think about the human being in all her relations to the product. If we had been more observant of the designing of products in our society, they maybe had looked different and had different qualities today (Hamrin & Nyberg, 1993). Developer of products should analyse the entire environment of the product, and to have in mind that the products real function, and construction is not identical with our own experience of them. There are big differences between people depending in personality, the environment, the knowledge, the profession, and economical responsibility. For example the reaction when a group of people watch a work of art, can vary from detest to enthusiasm (Hamrin & Nyberg, 1993).

In the study of Keirnan et al (2002), usability research is a way to gain insight into a product and its users. This can be about to learn what features of the product people use easily and successfully, and where and why they have problems. It is also important to observe users when performing a task with a product and then interviewing them and after that making an evaluation of the product. They assigned findings to some categories of usability issues.

- How users perform their typical tasks to achieve their goal with the product.
- How users' deals with feedback, user orientation, navigation, input and selection, and user's ability to recover from errors.
- How users deals with information design of pages, text readability, clarity of graphic elements, and fonts.

- Clarity and consistency of instructions and messages and that the names of everything are easy and clear.

According to Jordan (1988), users demand that the product is easy to use. Therefore, the usability issues have received increasing attention over the last few years. In addition, product designers and software programmers are increasingly expected to have an awareness of usability issues and to put the user at the centre of the design process. A product that is usable for one person will not necessarily be usable for another. When designing for usability we mean designing for those who will use the product in question. It is important to have an understanding of who the user of the product will be and their characteristics. Jordan (1988) claims that he experience the user has of using a product is important when trying to complete a task. That means that if a user has performed the task with the product or a similar product before, it will be easier for the user example guess what the next step will be. Cultural background, age and gender of the users, can also influence how they interact with products. The younger generations have grown up with a high exposure of computers and this may not be the case for older people. From this aspect, we easily conclude that older people are less accepting for computer based products compare with younger people.

Jordan (1988) claims that lack of usability can cause problems, which at one end of the scale may frustrate or annoy the user. The ISO definition of usability mentions three separate aspects – effectiveness, efficiency, and satisfaction. The effectiveness is one of the measurements of usability. The most basic measure of whether or not a product is effective for a particular task is whether the user can complete that task with the help of the product. If the user has problems to complete a task, the reason may be that the system is too complex and difficult. It is important that the system is easy and usable so the user does not have to use a manual to manage to use it (Jordan, 1988). Critical path is a measurable unit in the efficiency aspect and is a method of approaching the task that should require the least effort as possible i.e. the least steps or the least time to complete. If the user deviates from the critical path then this is negative in terms of efficiency. The quicker a user can complete a task with a product, the more efficient that product is for the task. Satisfaction is a level of comfort that the user feels when he uses the product. One way to investigate if the use is satisfied with the product is to ask them to make comments of the product and tell the investigator how they feel about the product. Normal questions can be if it was easy to use, if they enjoyed the product or if it was frustrating to use and of course if they liked or disliked the product (Jordan, 1988).

The goal is to improve a product's usability so that the participants represent real users, that they do real tasks, that testers observe and record the participants, and that they then analyse the data and recommend changes to fix the problems (Dicks, 2002). One problem is to gathering usability data and after that performing good usability tests. In the study of Dicks (2002) the author says that the results of a typically usability test are good enough to help us uncover problems with a product. You should have large sample of participants and a careful test construction for good results. Often the development managers are not willing to pay the price in time and money that such testing requires. If the sample is small, it does not matter because the test will even reduce most of the problems. He also claims in his discussion part of the study, that it is not easy to find enough participants for our tests.

The design should not only mediate messages, it should also be adjusted for example the users conditions, needs, desires and to the way the user observe the world around. The human being observations, perceptions of the world around occur through the organ of perception like sight, hearing, touching, heat, cold, pain, taste, and smell (Hamrin & Nyberg, 1993). Everything we can see around ourselves is coloured. Thanks to the colours we see, we will get qualitative information of the world around. Originally, the colour combination was help for the human being in fight for the living. Since a long time now, she uses it in ethical and technical context. The colour plans of our surroundings and our products are important. The

agreements of the colour symbols in the surroundings are in many situations vital information for us (Hamrin & Nyberg, 1993).

2.6 Designing for HCI (Human Computer Interaction)

2.6.1 Graphical User Interface (GUI) in general

When designers make the graphical user interface, they have to think about lot of things before they make their decision of how it should look like. Despite the GUI's popularity, surprisingly few programs exhibit good interface design. To find information and transfer this to good graphical user interface is very difficult. This often sees for many designers as a challenge.

In the study of Hobart (1995), applications must reflect the perspectives and behaviours of their users. To understand users fully, developers must first understand people because we all share common characteristics. A common complaint among users is that the application is not clear and consistent. According to Nygren (1997) the layout has to be aesthetic attractive and that is difficult to know because people have different opinion about this. Information that belongs to each other should be grouped. For example, a list should be arranged in a meaningful order like chronological, alphabetical, sequential, functional order to make it easier for the user to understand. It is also important that the user do not get lost in the system, i.e. knows what level he is in and knows what element he is observing. The feedback then had to be good enough to give the information the user needs to orientate. For example, it is good if the input the user has performed is quickly showed on the screen. If there is no immediate reaction of the user's action, the user will redo the action and that can give undesired consequences. The user should in every moment be sure that he or she wants to happen really happen.

Good GUI use consistent behaviour throughout the application and is build after the user's knowledge of other applications. The designer should know that people learn more easily by recognition that by recall. If the designer makes too many changes from what the user is used to, the user will feel lost in the application. It is important that the interface is smoothly to use but for example experienced users it is more important that the interface is easy to learn. It is never possible to form a suitable interface in all aspects, you have to make a compromise and decide what is the most important to realize (Nygren, 1997)

Hobart considers, in his study (1995) that developers often design for what they know not what the user knows. The user can then feel that the product is not usable. The GUI designer's likes to have control over the user by for example greying and blackening the items. This greying forces the user to do something else instead to use this particular item. It is important to not use these compulsions if the designer wants event-driven design. Hobart (1995) continues is that the designer should avoid putting everything on the first screen or load the toolbar with rarely used buttons. One thing to achieve successful GUIs is to use real world metaphors whenever it is possible. It is also important he continues that the application is fast enough otherwise it is possible that the user will abandon the system. One way to speed up the application is to avoid repainting the screen.

Nygren (1997) claims that the *screen size* is in general an important but limited resource in computer support. Often it is difficult to make place with everything you want in a screen. In many studies, they show that many tasks have been done quicker and safer on a bigger screen compare with a smaller screen where you can work quicker and make fewer mistakes. A smaller screen demands also a well-planned layout of the available screen. You should not "waste" the place with not important things as for example decorations. These decorations are maybe very nice in the beginning but after a while, you wish that you had used the place for more important things. For an experienced user it is not a problem if the screen contains too

much information if you have presented the information in a suitable way with good design and grouping of the colours etc. For a beginner, on the other hand, it is more difficult with to much information at the same time. Therefore, it is important to understand what user you are going to make your interface for.

It is a good idea, Nygren continues, to use some kind of a *summary* or some kind of *menu* system in the beginning of the application, from where the user should start his path trough the application. A *menu* is an enumeration of alternative that is eligible. We can find menus in many forms and normal traditional menus are when the alternatives are presented as a list on the screen. The designer should think about not to use more than two levels of cascading menus because it can be difficult for the user to follow. When designing it is important to think about how the grouping of the items in the menu is best placed for the best orientation in the interface. If the alternatives are grouped logically and the groups have describing names, it will be easier to understand them (Nygren, 1997).

Icons often should be used to strengthen a metaphor. A group of icons is also one type of a menu that is showing a number of alternatives of functions. It is good if an icon is self-illustrative but it is not necessary. It is better to use simple than to complicated icons and sometimes it is good to use icons that is a reduction of something that the user use very often and recognise. The designer should also use explaining text together with the icon is another way to solve the problem when the icons look the same. If there are similar buttons in many dialog windows, it can be a good idea to have a consistent placement for the buttons. An example is the “ok” button that always is best placed in the bottom of the page or the most right on the page you can come. Capital letters should also be avoided to use only in a text because of the legibility. The designer should carefully choose the best font for the interface. It is good if the user can choose to use between using the mouse and to make quick choices with keystrokes. It is also good if there is a possibility to go back directly to the top page with for example a keystroke (Nygren, 1997).

2.6.2 What is special for PDA

Since the device will be with us at all times, unlike a desktop computer, it will be used in variety of social context. How can the style of interaction be adapted to the user and the context of their current activity? The interface design for PDA is a little bit different compare with the design to an ordinary screen on a computer. The designer has to have in mind that the screen is smaller and that can bring a lot of different problems. According to Hobart (2001), the developing of effective interactive applications for low-resolution monochrome displays requires thoughtful planning.

Handheld computers restrict the amount of *screen space* available to an application, so, when developing applications for small screens, keep in mind that horizontal/vertical scrolling is not always the best solution. Instead, consider using hypertext links that easily and intuitively allowing you to navigate forward and backward. With handhelds, you should generally lean toward a deeper hierarchy rather than longer pages. Try splitting long documents into pieces and creating indexes where possible. When deciding what information to store on handheld, choose only, that which is most essential. In general, this means information that a user will access regularly or will urgently require in certain situations. When choosing *images* for use on devices, it is important to remember the size of the display (Kacin). If you are used to building extravagant sites with wild colours and patterns, you will undoubtedly find the small screen a frustrating environment. Try to avoid graphics that reduce readability. It is good practice to avoid large, detailed images. The easiest and most predictable way of deploying images on handhelds is to make your own custom bitmapped images, so that the software does not have to covert or resize them at all. It is also good practice to design your images with clean lines and simple shapes since elements that are more complicated tend to appear ragged. In other words, it is better to use an image that is deliberately simple, rather than to

try using a complex image that looks confusing. The importance when choosing fonts is to make it simple and to make tests (Kacin).

2.7 Related work

In the beginning of our thesis, literature studies and studies of other field studies were accomplished. A lot of ideas and thoughts about truck drivers and their environment were early influenced in the thesis and was an entrance for new ideas. The research that has the most influence in our work was about truck drivers in the long distance trade (Nehls, 1999). This is an ethnological culture analytic study of truck drivers' professional culture from the seventies until present time. Long distance drivers are a group that spends most of the time in the cabin that is both a working place and a home fore the drivers. According to Nehls (1999), the truck drivers' work is about to transport goods between different destinations. He can drive many miles on the road but at the same time found out to be in the same a place, because the truck driver turned out to be in the cabin all the time when driving. A truck driver often feels alone when driving. Sometimes they meet other truck drivers on the side of the road and normal topic of conversations are rules for driving, just in time deliveries, waiting times, and various departure times. The drivers show that they have a good social flexibility, a feeling of responsibility and they know the importance of the timetable of the transportation without damages. This sense of responsibility and the knowledge of that 95 % of the transportations is performed of the male population, gave some base for future ideas for services and design to our thesis (Nehls, 1999).

Luff and Heath (1998) examined the ways in which mobility is critical to collaborative work. The mobility of the individuals that move around different physical locations who require access to information and colleagues was named "remote mobility". This mobility is rather the same mobility we can find in our study where the drivers are walking from one location inside the truck to another location when loading, talk to customers or looking for example consignment notes. They examined three quite different settings each with different technological support. Those sites were the primary health consultations, constructions sites, and stations on London underground. They were interested in how individuals rely upon their own mobility and the mobility of particular artefacts to support for example collaboration. In the construction site, Luff and Heath continues, they developed a mobile system that was deployed to support the work for foremen. These foremen have to document things in different locations around the construction site. The record is completed everyday and the progress is monitored to identify problems and coordinate activities. They thought a notepad computer should be appropriate device to replace the paper allocation sheet. One problem was that they did not know if the technology was the most appropriate one. They discovered that the size, shape, and the low intensity of the lightning of the screen were a problem. Another thing they discovered was that it did not offer the support of the interaction of the paper allocation sheet. This was something we have thought about a lot because in our study, we want to use a mobile device in favour of manual handling of paper sheets. We did not want the users to go back to paper sheets again.

According to Esbjörnsson and Östergren (2002), the motorcyclists are a highly mobile group with strong social commitment. This is similar to our study with the truck drivers. The motorcyclists meet at places to share experiences with members of their own group. When they meet, they will for example impress with newly modified bikes etc. The aim of their study is to introduce a prototype supporting mobile group collaboration. The prototype named *Hochman* is a HTTP peer-to-peer application that enables sharing of HTML documents, audio clips, and images over ad-hoc networks. *Hochman* provides group awareness and with that means, when the users are in the vicinity of each other, they will be appended in each other's list of accessible peers.

The Conny project is about how to improve the work situation of truck drivers with web-technology (Nilrud & Wollerfjord, 1998). They have concentrated on long distance drivers. Their working situation is to drive for long periods without to have any actual college to talk to, and this is something that has been discovered in our thesis too. They discovered that the drivers use their mobile phone a lot. The researchers want to find out if web-technology could make the drivers happier and not so bored during their drive. It is very important that it is something that is not disturbing the driver when driving because of the danger in the traffic. They discovered that the right kind of product and design is difficult to find. The researcher and the user may have totally different understanding about the final product due to different backgrounds and perceptions of the work situations. The answer to solve this is qualitative interviews and ethnographical studies. The interviews studies will show when and how the drivers can be entertained by the web technology and the ethnographical studies will prove and verify the content of the interviews. This advice was usable for our thesis because our goal was to find different services for truck drivers.

In the project of Andersson & Johansson (2001), the purpose was to investigate the truck operator's needs and to see how modern digital technology can help to reduce the paper work and increase the productivity and make the operator's working situation better. The project will cover the truck drivers' needs for mobile communication, especially when working outside the driver's cabin. In their studies, they found out that the truck operator working with local distribution 1/3 of his time outside and 1/3 of his time inside. The operators are jumping in and out of the cab 10- 20 times a day, crawl amongst the cargo and make a dozen phone calls every day. The operators questioned the ergonomics of the today's mobile phones. They thought that is was too small buttons and too small screens. This they thought in this study leads to high requirements standards of any new information and communication device for this user group. Complaining of buttons and screens give us in our study support for our design that has big buttons and the device itself, has a bigger screen compared with a mobile phone.

In the project of Tang et al (2001), the authors report that progression of design ideas extends awareness research beyond the desktop to include mobile users. People need access to their information from a variety of locations and the application that shows the information should be efficient designed applications. They want to tell us about that the awareness information that often is transferred in face-to-face situations can be transferred also in other ways for example with mobile devices. The awareness information shows when these devices are actively being used and that is not always the case. In the project *Awarenex*, they talk about something that they called "Contact List" and this service tries to help you determine whether people are available for contact. Here the users are able to se names, their locations from where they are active, and any communication activity information. This kind of information is something we in our study used. Within an area, our user can see if a friend is nearby.

3 Method

In this section, the methods used in our study are described. The first method is a literature study, which will enhance our understanding of *Telematics*, computer systems in trucks and existing field studies about truck drivers. Secondly, a primarily brainstorming, delimitation, a procedure of finding problem areas in the truck drivers' profession, done by field studies, is described. Thirdly, the method use to analyse the discovered problem areas, in order to determine services for a prototype, is described. Finally, methods to design and test of the GUI, implement, and test the prototype are described.

3.1 Literature studies, delimitation and preliminary brainstorming

The first thing in our study was to collect information from databases on the Internet, encyclopaedias, journals, etc. Information collection was focused on Telematics, computer systems in trucks, and existing field studies about truck drivers. The idea with this litterateur study was to get a first insight into "truck transportation" and get inspiration from already developed computer systems devoted to "truck transportation".

In order to decrease the amount of information the previously discussed segments was limited to "distributed and long distance drivers". This limitation was done by a discussion within our group and with the instructor at Volvo technology Corp. The third segment, the construction segment, was excluded because it has major differences compared to the other two. Distributed and long haul segments are very similar with one major difference, the distance between start- and destination point.

Before our own conducted field studies, we started, with a preliminary brainstorming, in order to further increase knowledge and to generate ideas. The gained ideas and experience were later used in our discussion with the truck drivers.

3.2 Own conducted field studies

Another very important source of information was own conducted field studies. The filed studies were done in places where truck drivers normally could be found during their working hours. Places of interest were where truck drivers take brakes, where they maintain their truck, and where they load cargo. Observations in the field were necessary in order to understand truck drivers' mobile experience. We thought that spending a working day with one truck driver would probably give us a lot of input and would also be more useful than spending a shorter period of time with several others. We decided to make the field studies in one of the previously described segments, the distributed segment, in order to save time. It was also easier to get access to drivers in this segment compare to the long distance segment in which the drivers usually travel very far from home. The observations activities, from the field studies, yielded many significant insights that later provided inspiration for another brainstorming session, the main brainstorming session that will be described later on.

3.2.1 Field studies at "Stigs centre"

Our first observation in the field occurred at "Stigs Centre", which is a meeting place for truck drivers. That observation was superficial and lasted for a day. The purpose was to gather information about truck drivers' behaviour when they were not driving. The observation was hidden as Repstad also discuss in his book (1999) i.e. the drivers were not informed that they were observed. This observation gave us a first impression that was used a base in our future studies.

3.2.2 Field studies at "Bäckebols Åkeri"

The next field studies, were conducted at "Bäckebols Åkeri", which is a distributed haulage contractor transporting goods in Gothenburg's vicinity. We aimed to study truck drivers conducting their work and to gain knowledge of their working tasks. We were both assigned a driver that we accompanied during two working days. Both drivers were driving a Volvo FL (front low) truck (fig.2). The observation was open and active (Repstad, 1999). This means that we were discussing a lot of things with the driver and also asking questions. Sometimes we also helped them with loading of goods, which in fact gave us the advantage of be

regarded as a colleague. The observation, gave us a lot of information data about the working tasks conducted by a truck driver.

Figure 2. One of the trucks we joined

3.3 Analysis of the problems

3.3.1 Problem determination from own conducted field studies

The next step was to analyse the, from the studies, collected data and with that as a base determinate problems that occurred during a drivers working day. We tried to find problems that occurred when the driver was working outside the truck, in regards with the scope of this thesis. Determined problems were formulated as short and concise as possible and an explanation of the problem was added. A suitable method was a method taken from a compendium from Luleå University, called "Question method" (Hamrin & Nyberg, 1993). In this method you have to answer to some predetermined questions like:

1. What is the problem? Why does the problem exist?
2. Where can you find the problem? Why can you find it there?
3. When is the problem? Why does it exist then?
4. Who is involved in the problem? Why is just this person involved?
5. How frequent is the problem? Why is it frequent?

3.3.2 Examination and division of the problems

We divided the problems with the help of a method called *area division* (Hamrin & Nyberg, 1993). This method includes three different ways to divide a problem, and we decided to choose the one called *environmental division*. The *environmental division* method does also contain three different ways to divide a problem. We chose to use the "way" called *place.* That divided our determined problems into areas based on the different processes that occur during the haulage of goods.

3.3.3 Brainstorming and delimitations of the problems

The next step was to search for solutions of the determined problems. Brainstorming was the primary method used. Brainstorming sessions are further described by Hamrin and Nyberg (1993). During our brainstorming session criticism were not allowed. Instead a huge number of solutions were preferred and extraordinary solutions were welcomed. In this session a lot

of ideas and solutions were produced. After the brainstorming, we together with the instructor of the department of Volvo Technology Corp reduced the number of solutions to a manageable amount.

We know from the theory that end-users want usable products. Hence, it was important before we started the design process, to further understand the end-user and their specific characteristics. We had to have in mind, for instance, that the age and the gender of the end-users would influence our design. Younger people are more used to computers than older people. Our end-users were truck drivers, of both younger and older age groups, so the design had to suit both these categories.

3.4 Design

Next step was to design the services that were decided to be included in the application after the analysis phase. During the design, we used studies, books and input from the previous stages to get inspiration. Sketches were made on slips to se how design objects were connected to each other. Our instructor at Volvo Technology Corp suggested the method with sketches and we found it very useful for our work. This method was easy to work with allowing us to easily make changes. The sketches were later transferred into a GUI to make the sketches more precise and true. The development process we were using was an iterative process (Hackos and Redish, 1998). Designing, implementing, pre GUI testing, designing, implementing, pre GUI testing etc. This phase took about one week longer time than anticipated.

Interface design for mobile devices is a little different from the design of ordinary stationary screens. It was therefore important to have this in mind, for example the fact that the screen is much smaller, which may bring a lot of problems. Due to the size of the screen we had to very carefully decide what kind of information that was necessary to be viewed. Another very important issue was to use images and icon that are easy to grasp, but in the same time possible to transfer to the mobile device.

3.5 GUI Tests

After the design phase, it was time to gather usability data and perform a more thorough GUI test (appendix 2) and after that input further improve the design. This test was extremely important for further work with the implementation. The respondents were mainly from Volvo technology Corp. Truck drivers were not included in this test due to that we were only looking for the major design errors.

The respondents received different test tasks, written on a piece of paper. They were then asked to conduct the sated task. On the top of the piece of paper were also some words explained words in the menu that might be difficult to understand. The respondents were asked to conduct the given tasks by using our, in the previous section described, paper slips. When for example a button has been pushed, a new paper slip was placed in front of the respondent so that it should feel like it was a real application on a PDA. Before the test was conducted, each respondent was given a clear explanation of the system, and they were guided “trough” the system. During the tests, the respondents were allowed to speak and comment the GUI. When the tests were finished suggestion for improvements were discussed with the respondents.

3.6 Implementation

In this phase, we implemented a prototype with the services that were previously decided upon. The GUI improvements were already done on the piece of paper by that we had a clear picture of how the system should look alike and how it should work.

The first task was to decide the "technology" to be used for the development, i.e. what kind of mobile device, developing environment, and connectivity between the mobile device and the computer system in the truck. Another important thing was to discuss how we should simulate the computer in the truck since we did not have enough time to make integration in a real working environment nor did we have access to a truck. On the other hand, we only wanted to show how the services were working on the mobile device. Before the implementation started, we defined all actors (users and other systems that will interact with our system) and some of the necessary use cases, in order to structure the implementation work. These use cases described in detail, tasks, conducted by the actors.

We divided the work between us and started to implement the prototype with continuous tests that were done by our instructor, other Volvo employees, and ourselves.

We decided to use Compaq iPAQ 3900 as the mobile device, mainly because it was familiar to us (fig.3).

Figure 3. Compaq iPAQ 3900

iPAQ 3900 has a Blue Tooth built-in, so no additional iPAQ expansion pack was needed, which would have made the device bigger and heavier.

We used Java as the programming because it allows fast and "easy" programming. Another advantage with Java was that a Java compiler was provided with the PDA. The developing environment on PC was Borland JBuilder 5.0.

3.7 Prototype Test

The next and very important task after the implementation was to evaluate the prototype. The test (appendix 2) was composed of test tasks, written on a paper sheet. The idea was that the user should try to solve these tasks in a satisfying way. For the best result, it was important to use "real end-users", i.e. letting truck drivers be the respondents and test the prototype. The test was conducted in a canteen for the truck drivers (fig.4), and not in a "real environment". Each respondent executed the test tasks individually.

Prior to testing, each respondent was given a clear explanation of the how the system operated. The respondents were allowed to practise by operating the prototype before the test started. We used the method "Think aloud protocols", described by Jordan (1998), in which respondents should explain their actions during the test execution. If the respondents run into problems during the execution we helped them out. We recorded everything on a *MiniDisc* recorder, of course after asking the respondents permission. Recorded conversations would make it easier to afterwards draw conclusions from the tests. We took notes during the execution of the test tasks. Also spontaneous comments and discussions between respondents were observed and noted. (There were several persons in the room at the same time but the test was executed alone).

Figure 4. Prototype testing

4 Result analysis

In this chapter the results of each phase are presented. Firstly the result from our own conducted field study is described. Secondly, in the analysis phase, problems discovered in the field study are determined and later services worth implementing, in the prototype, are described. Thirdly results from the design phase and GUI test phases are expressed, and finally the implementation and test of the prototype are described.

4.1 Own conducted field studies

4.1.1 Field studies at "Stigs centre"

In the first field study we observed truck drivers in an environment where they meet to dine, maintain their trucks etc. The study was conducted at "Stigs Centre". We were observing drivers when they dined at McDonald's (at Stigs Centre) trying to find out what they were discussing during their lunch break. It was obvious that the truck drivers formed small groups, with approximately 4-5 persons in each group. Conversations were among other things about truck engines and gearboxes. Such conversation corresponds to what Nehls (1999) discuss in his book. We spent a fair amount of time, studying the drivers, but no additional information before we understood that it would not give us more information. Later we were walking around in "Stigs Centre" gathering information about establishment available for truck. We saw lunch bars, hotels, and big "service places" where chauffeurs maintain their trucks.

This first observation gave us an impression of what a chauffeur needs when he is outside of his truck. It also gave us ideas about what we should look for in further studies.

4.1.2 Field studies at "Bäckebols Åkeri"

The second study was conducted at "Bäckebols Åkeri". The staff manager showed us the place where truck drivers fetch *consignment notes**. The consignment notes were kept in a special compartment. Every consignment note had its own label, for example "G5" that told a truck driver which truck to use and the destination of the goods. A driver could match the label on the consignment note with labels in the ceiling, and by that find the truck and the corresponding goods. In order to make transportation more effective staffs were available to help truck drivers when they had problems, for example to find the right consignment note.

The staff manager helped us to find a chauffeur that we could follow during a working day. We were both assigned a chauffeur.

One conclusion after this field study was that loading consumed the major part of a truck drivers' working time (fig.5). Driving came in second place.

Figure 5. Loading the truck

Even administration was time consuming, e.g. when filling in consignment notes (fig.6) or when talking to the forwarding agent. This administrative work task seemed, for the drivers, to be the most annoying one. It happened very often that a heap of notes was lost and the chauffeur could not remember where he had put them. One example was a driver that searched for his consignment note, constantly swearing. He found them after approximately 15 minutes on a pallet.

*Consignment note; a piece of paper with all information about the goods and where the goods will be transported

Figure 6. Searching for consignment Note

4.2 Problem Analysis

In this section we describe the, from the field study, determined problems. These problems are then further analysed and allocated to certain problem areas. In a brainstorming session we tried to solve the problems by stating different solutions. In the brainstorming session also the best solutions were defined. Finally the services, i.e. the bets solutions, are described.

4.2.1 Determination of problems from own conducted field studies

We tried to determine the problems discovered during the field study and to clarify in which situation the problem occurred. We used the "Question method" (Hamrin & Nyberg, 1993), discussed in the method section.

Excerpt
One of the chauffeurs, called "Lasse", said that his day would be tedious because he would have to drive to different spots (he called it "lösen"). He claimed that it should be boring for us.

We thought that it was a very good idea to go along because this would help us to discover more problems during the day.

Excerpt
One of the truck drivers talked about that he did not lock the doors on the truck in former days, but after a burglary in the truck he nowadays lock the doors every time he leaves the truck.

This made us to think about the safety of truck drivers' belongings and the goods he was transporting. Something could be done to make it easier and safer for the truck driver. He is often leaving the truck when loading, unloading, or when taking a break. Unfortunately, he sometimes left the cabin door unlocked. If the ignition key is left inside the truck, the goods or even worse the truck could be stolen, the driver maybe not always would be aware of the sound from the alarm if he is far away from the vehicle. The truck driver sometimes enters the truck at night and when it is dark, it could be an unpleasant situation for the driver.

The truck driver does not always check the load indicator inside the truck when loading or unloading. If the truck is overloaded, there may be some problem for example if the police stop the truck for controls. One of the chauffeurs claimed also that the truck is not that easy to manipulate in dangerous situations if the truck is loaded in a wrong way.

Excerpt
When we asked some truck drivers in the storage place if we could take some pictures, one of them said:
"Do you have wide-angle lens with you? If you want to have "Kalle" on the picture you need that." Every one around started to laugh. "Kalle" said to us:" If you will work here you have to get used to it".

Excerpt
One of our truck drivers needed some help with one of his pallets and asked another truck driver nearby to help him with the pallet. The truck driver helped him at once without any complaints.

In this excerpt, we could see the special pattern of behaviour that we also could find in the literature (Nehls, 1999). When talking to the truck driver we joined later on, we understood that this jargon was something that belonged to their working day. Something that maybe makes them feels comfortable with the work and with each other. They liked to talk with each other about friends and to make jokes with each other. We felt that it was a special solidarity between the truck drivers.

We learned that truck driving is usually a very lonely type of work. To determine the location of friends the driver uses his mobile phone or the communication radio. A mobile device may be used to enhance a truck driver's possibility to determine the location of his colleagues.

Excerpt
The truck driver was looking for goods that he could not find. He was walking back, forward, and said after a while: "This is not good. There is no order of the pallets .It is important to find the consignment note that belonged to the right goods otherwise there may be a lot of problems. The customer is going to sign this consignment note and it is important the right one on the heap. It should be some staff here to help us with this kind of problems but they have disappeared and I cannot find them. That happens now and then."

The goods were left behind this time but could have been transported of this truck driver if the system had been more efficient. The truck driver had to look for the staff that should have helped him but could not find them. During loading of cargo a truck driver occasionally needs to search, in the warehouse, for missing goods and consignment notes. If the missing goods cannot be found in a reasonable period, the driver has to leave without these goods due to time constraints. The warehousemen negligence is one factor causing this problem, which of course leads to delays in the shipment of the cargo.

When the truck is loaded the driver needs to wait, in a queue with other truck drivers, in order to get the loaded goods ticked off. The goods are ticked off on the consignment notes by the office staff and at the same time the consignment notes applies a destination code. The information of the customers' opening and closing hours is sometimes missing on the consignment note. If the customer site is closed, the driver occasionally can deliver goods to another customer instead. However, sometimes the goods that were supposed to be delivered blocks the remainder of the loaded goods and, in such case the driver just have to wait.

The truck driver receives short messages from the forwarding agent, via a fleet management or via SMS on a mobile phone, during the deliveries. The fleet management give a good presentation of the messages but cannot be brought from the truck. The mobile phone on the other hand is movable but the limitation of text presentation, because of the smaller display, makes deleting a message easy. This will force the truck driver to make a new phone call to the haulage contractor for further information. When the truck driver reads the messages regarding fetching goods, he has to calculate if he has the space for all goods on the truck. If

the calculation will show that there is not enough room for some of the goods he has to call back to explain this for the haulage contractor.

Excerpt
One of the truck drivers had a bad habit to put his consignment notes everywhere in the truck and had difficulties to find them. After ten minutes, he found the right consignment note and could continue with his loading.

The delay with the loading because of the searching of something that is missing was again discovered. The driver usually has one pile of "delivery-notes" and one pile of "collection-notes" inside the truck. Usually this is not a problem but it may happen that the driver mixes the notes between the different piles when for example new "collection-notes" are placed behind the "delivery-notes". The truck driver is therefore unfortunately reluctant to bring the consignment notes from the truck, because he is afraid of ruin the order of them. There will be some paper to keep track of when the customer will sign the consignment note to confirm that the goods have arrived. The customer will also keep a copy of the consignment note, given by the truck driver.

When the truck driver is fetching goods by the customer he will check the goods and the belonging consignment notes. He will then stamp all consignment notes, with his id-number, before he leaves copies of the consignment notes to the customer. At the end of the working day, the truck will be unloaded at the forwarding agent with goods brought from customers. The driver has to wait again in a queue with other truck drivers, in order to get the unloaded goods ticked off. The goods are ticked off by the office staff and at the same time the consignment notes applies a destination code.

If the truck driver wants a short description of the items on the dashboard, he needs a Volvo truck handbook for dashboards. Searching in those kinds of books is often very boring and time consuming. This was something we were thinking about when joining the truck drivers.

4.2.2 Examination and division of the problems

We analysed the determined problems we found and divided them into problem areas based on the different processes that occur during the haulage of goods. This division was not only based on the field studies it was also an understanding from literature studies (Andersson et al. 2001, Nilrud et al. 1998). The areas where we could find problems, and where the transport efficiency could be improved, were at the warehouse and at the customers'. Another place where we could find problems was at the administration with the paper work the truck drivers had to deal with. The truck drivers also feel alone during the drive and when having lunch. The areas we found were further divided into three categories we thought were suitable for our study.

- Transport efficiency
- Administration
- Social interaction

4.2.3 Brainstorming and delimitations of the problems

After this division, we started with brainstorming to find a lot of ideas for our future prototype. It showed to be a lot of ideas so there was a need to do delimitation of the ideas. This was done with our instructor at Volvo Technology Corp, to find the most interesting services for our problems.

4.2.4 The most interesting services meant to be implemented

Here we present the services that we thought was worth to implement in our first prototype. The background fact from our own conducted field studies and literature studies (Andersson et al. 2001, Nilrud et al.1998) describes why we thought there was a need of these services. The services have been sorted after the three categories mentioned above. The reason that we chose this wide set of services was to get a feeling in which direction to go in the future work.

Transport efficiency

Load indicator
The reason that we wanted to implement this service was that it was already present in the cabin in some of Volvos trucks. When driver is loading goods, he is not in the cabin and cannot see the presented information so it was perfect to move that information outside the truck and show it on the mobile device. The load system service on the PDA would be similar to the already existing system in the truck cabin where current load weight for all trucks' axles is presented. The only difference was that our version of this service should "know" the highest allowed weights and it should display a warning message when there has been some kind of override. There should also be a possibility to view the total weight of the goods.

Driver's manual
This service would not be implemented in our prototype or tested but there was an idea to include a manual for more efficient truck driving, especially for beginners. There should have been a text based help service on the PDA to make it easier for the driver to search for the description of a specific item. It should have been a service, which gives the driver the possibility to use the manual outside of the truck, for example during a lunch break. The information in this help service should have been structured in a similar fashion as the truck handbook and extended with search capabilities. This was nothing we discovered in our study but we thought that it would be easier to navigate in the digital manual compared to search for a special page in a book.

Automatic lock
The driver would have the possibility to choose locking the doors manually or automatically. In the automatic alternative, the truck doors would be locked when the driver, with his PDA, has left the truck and is outside of a certain radius from the track centre. When the truck driver approaches the truck, with his PDA, and steps inside the radius the doors would automatically be unlocked. Inside the radius, the driver would always have the possibility to lock the door manually if so desired. This idea came up when one of the drivers, in the field study, told us how once a mobile phone was stolen from the cabin.

Remote control for lights
If it were dark outside the driver would have the possibility to switch on and off the lights of the truck manually or automatically. When the truck driver would approach the truck, with his PDA, and steps inside the radius the light on the truck will automatically be lighted. Inside the radius, the driver would always have the possibility to switch off the lights manually if so desired.

Alarm on PDA
This service would notify the truck driver if the truck were exposed of a burglary. This was something that one of the truck drivers mentioned in our field studies. The service would utilize the existing truck alarm system but also be extended with additional alarm capabilities. An additional alarm should be raised if an unauthorized person was entering the truck platform. The only authorized person would be the one having the drivers PDA. The truck driver would have the possibility to activate and deactivate the alarm facility using the PDA.

This service would be on higher priority than other services, which means when alarm activates the service should appear in the foreground and the driver should be notified.

Administration

Consignment note
A consignment note is a form that includes information for a whole order. This form has to be signed when received by receiver, which gets a copy of the form, while the original sends to the sender of the goods. There could be done a lot of administration job automatically, such as sending the notes to all the involved people by making electronically consignment notes. We saw for example in our own conducted field studies that the driver's experiences to put the heap of notes in order were sometimes a problem.

The truck driver would have all the information about the goods, downloaded to the mobile device, before loading the truck for example the destination, the name of the customer, the client note, the business hours, piece of goods, the weight etc.
Below we tried to cover the most of the situations that can arise when working with consignment notes.

Missing goods when loading from the warehouse
After the truck driver has placed the consignment note in a special list for missing goods, in the PDA, messages automatically would be sending to the haulage contractor.
During loading the truck, missing goods have been found in a reasonable time to be loaded.

Waiting at the warehouse for the note to be ticked off
Instead of waiting for the note to be ticked off there would be a list in the PDA, for loaded goods on the truck, which is directly sent to the haulage contractor.

Opening and closing hours
The truck drivers route planning would be easier when the opening and closing hours automatically will be printed on the digital consignment note. This information would be gathered in a database so the customers or the haulage contractor doesn't have to print this on the consignment note every time there will be a transport.

Send and receive messages
To solve the problem with the incoming messages the PDA would be perfect for this purpose. New fetching of goods should be stored in a list for waiting goods in the PDA. The truck driver can then accept or decline the goods depending on the space in the truck.

Truck space calculation
The sum of the volume and the weight of the goods inside and planned goods to be loaded would be printed on the PDA. There will be information about loading of goods and it will send information automatically to the haulage contractor of the condition.

Possibility to mix consignment notes
When the driver has to wait for the customer, there would be a good opportunity to plan for the upcoming deliveries. The PDA would contain two different kinds of lists that keep the order of the consignment notes. One list would be for waiting goods and one list for the goods that would be delivered. This would simplify the work with the consignment note and help the truck driver to have the consignment organized.

Customers' signature
The signature would be done directly on the PDA and directly after the signature, it would be sent to a server at the haulage contractor, and a copy is then sent back to the customer as e-

mail. The customer has now a possibility to save a digital consignment note or to print it, if they want a paper copy.

Stamping the consignment notes
The customer should be able to send the consignment notes to the haulage contractor, which forwards them to the right truck driver's PDA. The consignment notes would then automatically be stamped with the id number of the truck driver. That saves a lot of time for the truck driver.

Waiting at the warehouse for the note to be ticked off
Instead of waiting for the note to be ticked off there would be a list in the PDA, for loaded goods on the truck, which is directly sent to the haulage contractor. The goods would also automatically have the special code for destinations for the staff at the warehouse to work with.

Social interaction:

Friend finder
The loneliness truck drivers' sometimes experience can surely be solved in many ways. Here we will explain one service that can be comparable with services that already exist today but maybe not for truck drivers. When a colleague is in the vicinity of the drivers PDA a connection between his and the colleague PDA would be established, and this would be highlighted on the PDAs. The truck driver should be able to view, in a list or on a map, all colleagues that are in the vicinity. The truck driver would on the PDA, maintain a list of colleagues. He can add and delete that part of this service.

4.3 Design

Here we describe the final design of our prototype. We made a difference between system design, which tell about the construction of the program, and GUI design, which describes the visible parts of the program.

4.3.1 System design

Simplicity has been the key word in the overall architecture, mainly due to time constraints. Simplicity will also decrease the learning time for developers who like to further enhance and develop the application.

The goal was to bundle the access to all services in one GUI, in order for consistency and accessibility. To achieve this we build the application, the access to the services, in a tree structure (fig.7). To avoid too many, time consuming, clicks we tried to flatten the menu structure. Every service should be accessible from all other services, i.e. from all nodes in the tree (fig. 7). By that the user could navigate in the easiest possible way. An idea was also to show the current path, i.e. where in the "tree" the user has navigated to, in order to further extend the navigation possibility. Though because lacks of time this feature was not implemented.

We realised that it easier for truck drivers to use their fingers when using the services instead of using the to the PDA belonging pen, a pen which is very small and easy to lose. To realize this, the application must consist of large buttons and other areas that easily can be clicked. We soon discovered that size of the screen (320x240 pixels) made it difficult to fulfil every wish we had for the interface.

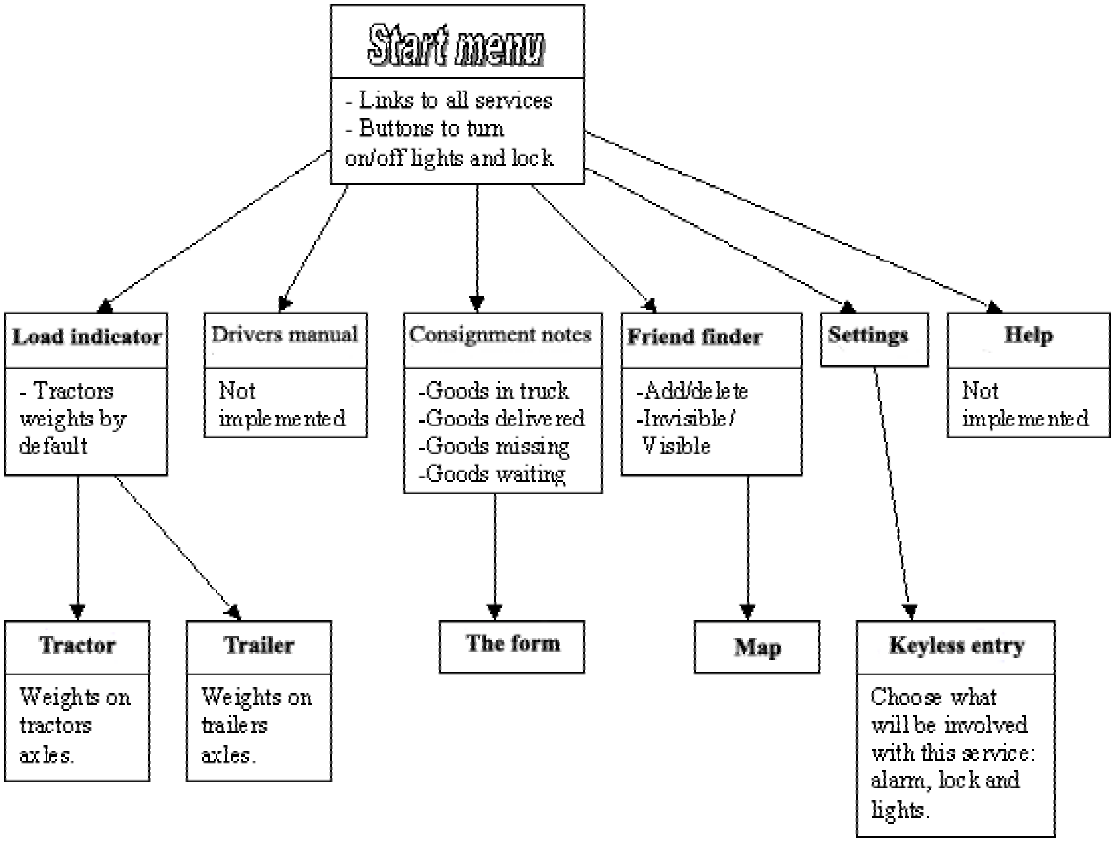

Figure 7. Application diagram

4.3.2 GUI design

The two main reasons for designing a GUI were:

- To visualize how the services will look like in a more "real environment", since you all know that a "picture says more than thousands of words".
- To be able to verify that the services "really" are needed by the end-users.

The application *Mobidrive* we designed was finished after a lot of pre-tests and discussion with our instructor. During our work with the design, we encounter a lot of problems.

The small *screen size* was something we soon found very frustrating because it was difficult to make place with everything we wanted in the screen. We understood that the screen needed a well-planned disposition of the elements and that we should not waste the place with a lot of unnecessary things. The orientation was made as easy as possible so the page the user wants to see after a performed task is the expected page. We felt that it was important to carefully think through everything before we made the choices for elements and their places because it was important that the elements did not have the same look and feeling. The user should clearly see which element it is on the screen for the moment, without reading what it is.

Using images compatible with our display capability was also a challenge. When choosing *images* for use on the device we learned from literature (Kacin, Hobart, 2001) and of experience to avoid large, detailed images. We searched on the Internet for good and understandable icons that could explain and clarify our services, for example in the menu. When resizing the icons we had to agree with the literature (Kacin). Icons that had round forms had a faculty to get a ragged form when resizing to smaller size. After some retouching,

to remove the ugly edges we succeeded to fix some of the icons and they could then be used for our design. Directly after the icon, we put a belonging text that should clearly explain the services. Further, we had to think about the font and style. We used small letters and the same font through all the design to make it as easy as possible. The buttons were made as big as possible for what the screen size allowed. We tried to have a consistent placement for the buttons for example the “menu” button is placed in the same place in all pages where you will have the possibility to go back directly to the menu page. For good usability, it is important that the user has a chance to regret his choices. Therefore there are two buttons at the bottom of the page there the user can choose to agree with the changes in the setting by using the “ok” button or not agree with the changes by using the “cancel button”. We thought also that it was a good idea if the user could choose the pen, or to make quick choices with keystrokes. This means that the user can go back directly to the top page by using keystrokes instead of using the belonging pen.

Below we show pictures of what it could look like when we designed for the PDA. First, the menu site (fig.8), that is the first page you come to when you run the application. We used icons that we wanted to use later in the prototype so it would look like the real prototype when testing the GUI.

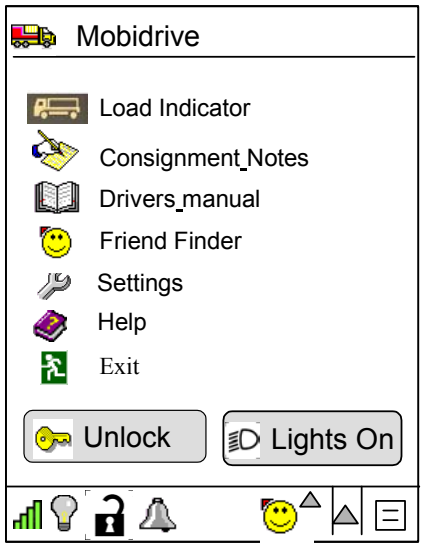

Figure 8. The menu

Another example of the design is the Load Indicator (fig.9) where we tried to make the truck drivers recognise the load indicator already exciting in the truck by using the same pictures of the truck. On the other hand, we wanted to make it easier by showing the loading figures with images to make it clearer instead of only using figures as in the existing load indicator in the truck.

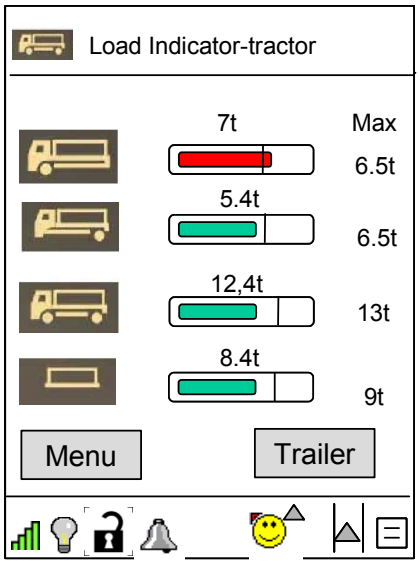

Figure 9. Load Indicator

4.4 GUI Test

When we had made an example for the design, we performed a GUI test that gave us some clues of what could be wrong. As expected, this GUI test brought some corrections to the tested design. The respondents almost complained on same things, so we were certain about what to change. The difficulty to test a computer graphics on paper slips were an unpleasant discovery because paper one-dimensional look and feel doesn't look the same as the computers three-dimensional look and feel. This was obvious in the "Consignment Notes" where the drop-down list was not discovered. After all, the respondents were interested in the design and thought it was easy to understand. This was something that gave us information that we were in the right way for our design anyhow in the respondents' opinions.

4.4.1 Changes in the GUI

In "start menu":
Bigger buttons with icons is implemented in front of the text so it will be clearer what will happen when pressing them. Separate the icons on the status bar (buttons and no buttons) because it is unclear to see directly which is which. Icons for not active services will have a different colour.

In "Friend finder":
"On/Off" button will be changed to Activate/Deactivate. Search will be changed to Add because the goal of that function is to add a person to the list.
"Invisible/Visible" button is changed to "Make me invisible/visible" to avoid the misunderstanding about the status.
Check boxes are placed in front of each row to make it easier to delete friends

In "Settings":
"Auto lock" changed to "Lock settings" because there is a possibility to lock manually too.
"Approach lights" changed to "Lights" because there is a possibility to adjust manually too.

No changes were done by the drop-down list in the "Consignment Notes" because we concluded together with our respondents that the real error is that the drop-down list is on a

paper slip. They agreed with us that it would be no problem if the test had been on a real computer screen.

4.5 The updated design after the GUI test

The start menu (fig.10) was the first to be designed. Here we tried to make it as simple as possible with no decorations that disturb the appearance and simplicity of the interface. We discovered that when decorations took place and that too detailed background pictures made the user confused.

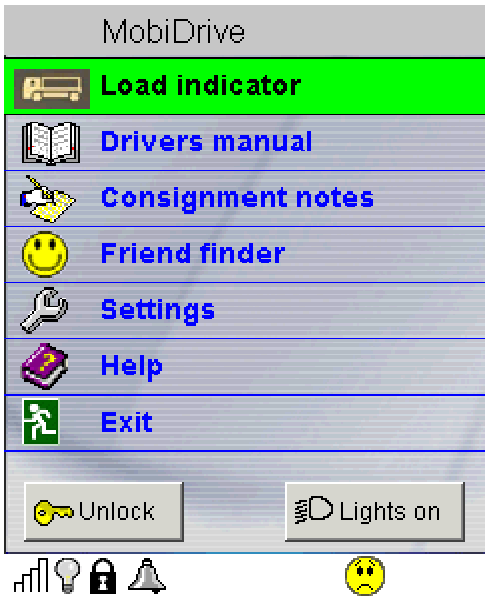

Figure 10. The start menu

The menu is made like alternatives presented as a list on the screen. The order of the services in the menu is after what we thought was the most important service for the truck driver i.e. the most used service at the top of the page. From literature (Kacin), we learned that it was better to use simple than too complicated icons and to use icons that the user use very often and recognise. We tried to use as easy icons as possible and used explaining text together with the icon to make it easier to understand.

At the bottom of the page, there are icons that tell the state of different conditions. On the left hand side, the coverage symbol, tells if the user is in coverage (green) or not (transparent). There is a possibility to turn on/off the lamp and lock/unlock the padlock manually with the big buttons or it happens automatically if the user has chosen this in the settings service. When the alarm is activated, a dialog pops up on the page and gives information that someone is trying to steel the truck. If these last three services are turned on in settings, you can see a little blue round mark next to the icon. The smiley icon has an arrow at the top of the icon when friends are nearby. It also changes the colour and appearance depending on the user's settings. When pushing the two buttons in this page they change names to "Lock" and "Lights Off". This is important for the feedback so the user knows if they have changed the state or not.

In "Load Indicator" (fig.11) like the other services, we have tried to make the elements in bigger sizes, because it will be easier to use for truck drivers. When the user looks at this page, they will have information of the load status of the tractor. If they want to have information of the load status of the trailer, they just have to push the button called "trailer" in

the right corner at the bottom of the page. If the truck driver overload one of the axletree without this service has been chosen, this page all the same pop up and shows the axletree where the problem occurs.

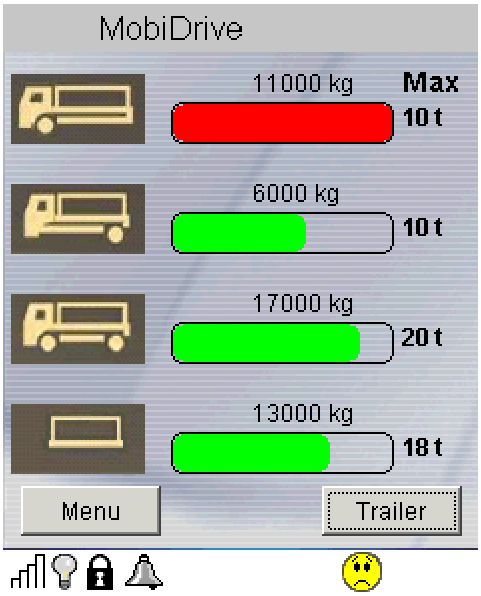

Figure 11. Load Indicator

We understood from literature (Nygren, 1997) that end-users better understand an interface if they recognize elements or places. Therefore, we used the same axle load pictures, we could find in the present "Load Indicator" in Volvo trucks today. The status of the load on the other hand is changed for better illustration. The present "Load Indicator" in trucks (appendix 3) just shows the figures of the results. In our design, we wanted to illustrate more clearly with dynamic bars illustrations. When everything is fine the bars is green but turned to a red colour when it is overloaded.

In "Consignment Notes" (fig.12), the user will have possibility to look for and go through a special consignment note. At the top of the page, there is a "drop down list" where different choices of lists can be chosen. The choices are goods inside the truck, waiting at customers or at the distributor, delivered or goods that are missing.

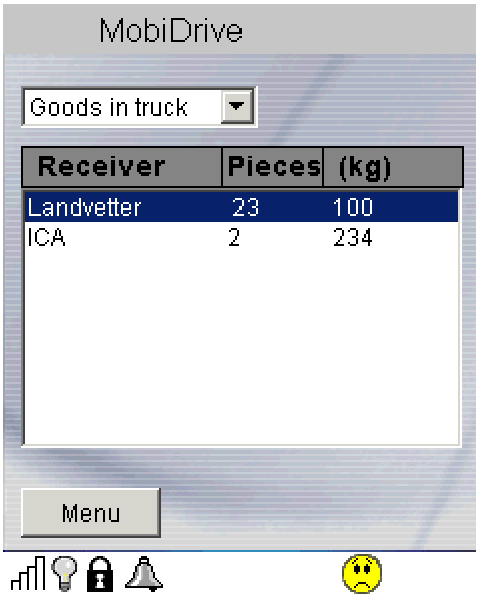

Figure 12. Consignment Notes

There is a link belonging to every consignment note where the user can choose to look at a special consignment note. The consignment note is shown with a scrollbar so the user has to scroll to look through all the contents before signing electronically (fig.13, 14, and 15). In this page, the idea is that the same information is showed as in a normal consignment note. This was very difficult because it was a lot of information that should be placed in the same page.

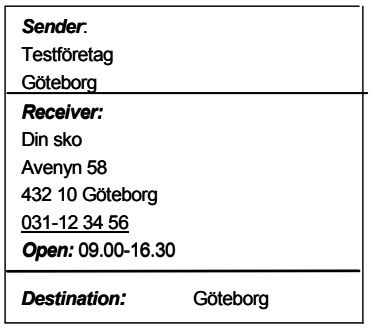

Figure 13. The first part

Figure 14. The middle part

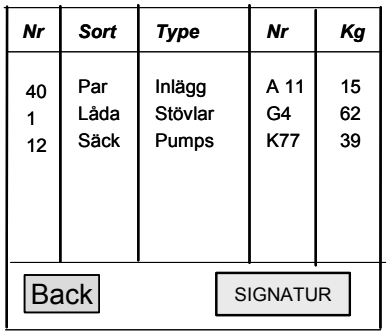

Figure 15. The last part

In “Friend Finder” (fig.16), there are possibilities to make settings for what setting the user wants. The user is able to choose if the service should be on at all by using the button “Activate” or if he wants to be invisible to his friends by using the button “Make me invisible”. When pushing these two buttons they change names to “Deactivate” and “Make me visible”. This is important for the feedback so the user knows if they have changed the state or not. With the buttons “Add” and “Delete” to the right at the top of the page, the user has the possibility to add or delete friends to the friend list in the middle of the page. The friend list in this page contains friends that the user is able to see if they are in the neighbourhood. The user can see this by pushing the arrow that belongs to the smiley icon or on a map by pushing the “map” button at the bottom of the page.

Figure 16. Friend Finder

When adding a friend to the friend list, the user can search in a large database for friends (fig.17). By choosing "ok" button after printing nickname, name or/and mobile number, the user comes to the database for friends. Here it is also possible to change their mind if they regret what they have chosen by using "cancel" button.

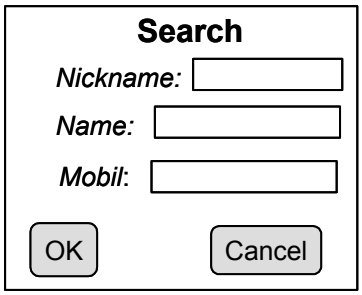

Figure 17. Search in database

In the service "Keyless Entry" (fig.18), the user has the possibility to set different status for the keyless entry and how big the area around the truck that should be covered. In the lock settings, you can choose if the driver's door or booth doors in the cabin should be locked or not when arrive or leave the truck. The same happens to the light when you choose the load light, spotlight, or both, the light should be turned on or off when arrive or leave the truck. The alarm choice can be chosen if the user wants to hear from every location if someone tries to steel the truck. If this happens, a dialog pops up and gives this information to the user.

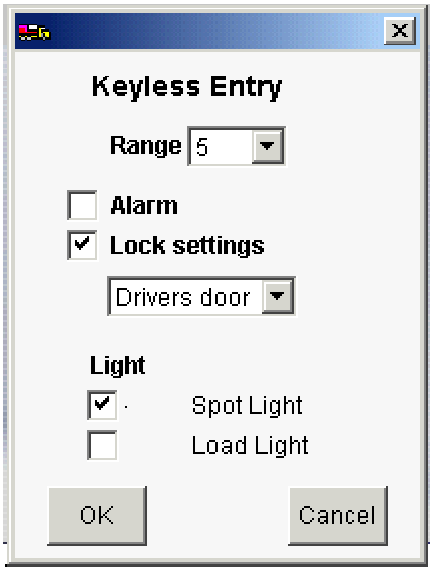

Figure 18. Keyless Entry

For good usability, it is important that the user has a chance to regret his choices. Therefore there are two buttons at the bottom of the page where the user can choose to agree with the changes in the setting by using the "ok" button or not agree with the changes by using the "cancel button".

4.6 Implementation of the prototype

In this chapter, we describe all users of the system that is not only the truck driver and his truck. By the user, we mean all people and other systems that in some way use our system. It is important to detect those actors before starting implementing. Finally, we describe the parts of the system, first the client (services on PDA) and then the server.

4.6.1 Actors that is involved in the system

The actors are a driver, a truck, a forwarding agent, and a receiver who will sign for delivered goods. By the truck, we mean the different systems in the truck that will communicate with our system. A truck will interact with the system in a two-way connection. The driver's place is inside the truck while driving, but even outside while loading goods or maintaining the truck or waiting for directions from the forwarding agent. He gets his directions by a forwarding agent who contacts him when a new order appears. Usually the directions are about to pick up goods and the driver has now a chance to accept or decline the directions depending if there is room in the truck or not. The connection sometimes goes from the opposite direction; from the driver to the forwarding agent e.g. when the driver needs further instructions or when unexpected problems come up.

For our prototype, we needed to simulate all actors but the user. Because of the difficulty to make the implementation in the real place i.e. the environment of a truck, the truck and forwarding agent will be simulated by a laptop. We decided to make a server-client service where the application on the PDA would be the client and the application on the PC would be the server. The application on the PC would contain the truck functions: alarm, lighting, locking and loading, forwarding agent functions: sending consignment notes and even functions when meeting a friend, by sending a signal that a friend is close.

4.6.2 How the prototype meant to be used

Here we describe more in detail how different parts of the prototype are expected to work. Firstly, we describe the server (fig.19) that is a simulator constructed to run on a PC. This simulator is representing all actors that will use the system except the truck driver who runs his part on a PDA. Secondly we describe the services on PDA and how they interact with the simulator.

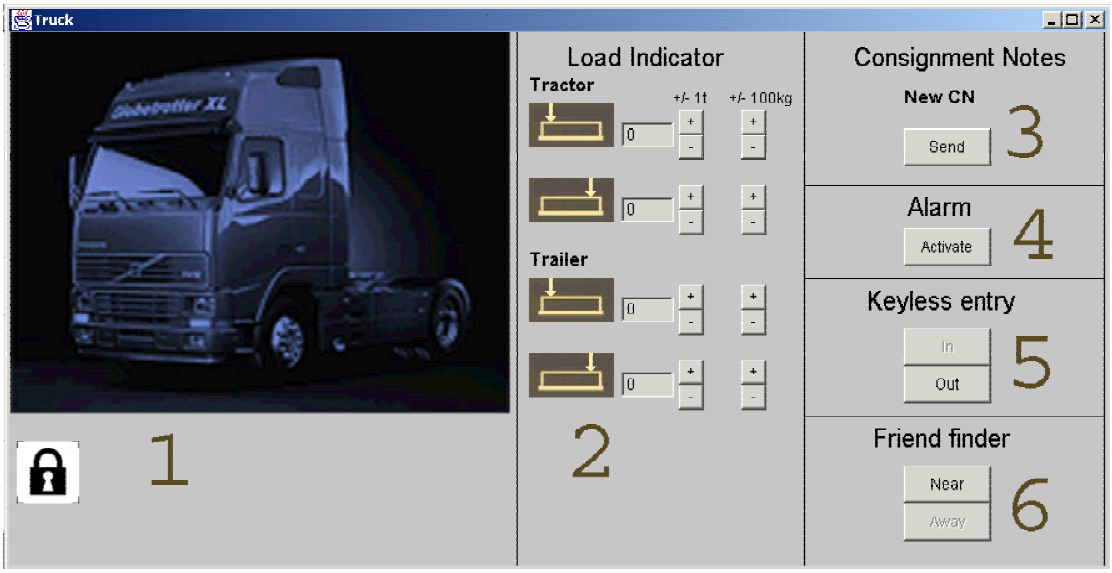

Figure 19. Server acting: a truck, a forwarding agent, and a friend.

The simulator:

As the figure 19 shows, there are six parts that build up the simulator's interface: 1, 2 and 4 represents the truck, 3 is a forwarding agent, 5 are not actors but represent a situation and 6 is a friend.

1. A picture of a truck that shows when lamps are turned on and a lock symbol that shows lock status.
2. Buttons for loading/unloading purposes. There is an ability to "load/unload" either front or rear part of tractor or trailer. There are two sets of buttons: one for +/- 1 ton and the other for +/- 100 kg. Loading status is always shown on a PDA.
3. Acting a forwarding agent there is an ability of sending a consignment note to a driver by clicking on a send-button.
4. Clicking on an activate-button makes a dialog box with an alarm message to show up on the PDA.
5. When "Keyless entry" services are activated, there is a need to simulate when the user goes into the coverage area and when he goes out from the coverage area. That is achieved by pressing in/out buttons.
6. Friend finder. Pressing a near-button indicates that a friend is near. Away-button indicates that no friends are nearby.

The services on PDA:

Load indicator
This service presents actual load weight on a certain axle. When load weight is increased or decreased on the simulator, it sends that information to the PDA that shows it. Since the PDA, "knows" the most allowed load weights on each axle it gives a warning if those are exceeded. This warning is in form of a dialog box that appears independently of where the user is in the

system now. When pressing “Ok” button the information about the load status where the error has appeared is shown. That can be either on the tractor or on the trailer side.

Driver’s manual (not implemented)
To develop the skills that professional drivers already have, so that they can get the best from their Volvo Truck in terms of performance, fuel consumption, and impact on the environment. This would work as an electronic handbook where the user can search descriptions about the vehicle through the current topics, index or by typing in the searched word.

Consignment notes
This service is constructed so that there are four tables where the consignment notes can be added: goods waiting (goods that are waiting in some warehouse to be picked up), goods in truck (goods that are loaded on the truck), goods delivered (goods that has been delivered to the receiver) and goods missing (goods that can not be found). Rows of those tables contain the most interesting information (conclusion from the field studies) that is: receiver, the total weight, and total number pieces (usually packets). When clicking on each row a whole consignment note opens showing the details of the order.

When clicking on “Send” button on the simulator it causes a new dialog box on PDA that asks the user if he wants to take an offer to accept a new order to transport. If accepting a consignment note for this, the order is added to the “waiting”-table, otherwise the dialog box just disappears.

Friend finder
Since this service is to detect friends that are in the vicinity, we had to implement that situation that indicates when a friend is near (“Near” button on the simulator). When pressing that button the PDA user gets a pop-up message containing names. When clicking on one of those names a pop-up opens containing further information about that person. There is a possibility to open a map and see the location of both him (the users) and the friends. There is even a possibility to deactivate this service.

Keyless entry
When this service is activated, there will be two situations when the user will be aware of its existence. One is when passing into the coverage area and the other is when passing out from coverage area. To create those situations we added “In” and “Out” buttons in the simulator.

Manually lighting and locking
There are two buttons on the start menu with which the user can turn on the lights of the vehicle and lock it. When doing this, the pictures on the simulator changes, showing a lighted truck or a closed lock.

4.7 Prototype Test

Finally, the last step of the prototype development was to test the prototype on truck drivers who maybe will use the prototype some day.

4.7.1 Test and evaluation of the prototype

We went to “Bäckebols Åkeri” where we did our own conducted field studies. The test has been performed in their coffee room between 15.00 and 19.00. Drivers dropped in one by one when their working day was ended. We asked them if they would like to participate in the test. As a help of assistance for testing, we brought, except the laptop and the PDA, a photo camera and a MiniDisc recorder so we could record the spontaneous conversation that started

when testing, especially when there were many drivers present at the same time. Off course, we asked if it was ok to record before start recording.

We discovered that testing truck drivers would not be easy because they are very mobile in their work. We had only two options to test either in the morning before they drive away for work or in the afternoon before they go home. We went there in the afternoon because we thought that the drivers should feel less pressured after the day's work was done. Anyway, we succeeded to get seven persons to participate in our test, one of them was a long distance driver, and the rest work as distributed drivers. Approximately ten persons declined because they were in a hurry.

The conclusions after testing are that most of our test persons (fig.20) were very interested in the services we showed them.

Figure 20. Respondent testing the prototype

Some of them came with own suggestions of improvements and even completely new services. No one had a problem that the application text is in English, but they suggested that a multi-language choice should be added to the system. One thing we noticed about their orientation when using the program was when they were looking for buttons the first glace was usually at the upper part of the screen. We assumed that this problem appeared because new users are a little bit uncertain where all buttons are or what they are used for and are used to take a first look at the upper part of the screen. All test persons said that after a given time of using the program there would be no problems using the device. One interesting thing about the map function in "Friend finder" service was, when several of them saw the map with friends, they thought that there is a possibility to navigate to the final destination, with help of that map. We were talking about that idea in the beginning of our project but for some reason it were putt away. "Keyless entry" service did not make a big impression on them, the most of them did not give many comments, and some thought that "lock thing" was good for security. "Auto lightning" would take too much power from the trucks accumulator especially on older trucks. One who liked "Load indicator" expressed his feelings about the automatic locks and lights: "The other thing with locks and lamps is just a lot of trash, but it has to do with security I suppose".

5 Discussion

Instructions from Volvo Technology Corp were to find several services used on a mobile devices by truck drivers' in their profession. We tried to discover and evaluate services in different areas, like services for social interaction, to control the truck and to handle administrative tasks. Social interaction is a fashionable area, which of course could be applied

on truck drivers as well. Controlling the truck is the most obvious one and a lot of services could be examined. Handling administrative tasks is for many people a boring work task, so also for truck drivers. New services in this area are therefore always welcome as long as they decrease the administrative workload and at the same time do not take a lot of effort to learn.

Cultural background, age and gender of end-users, can also influence how they interact with products. The younger generations have grown up with a high exposure of computers and this may not be the case for older people. From this aspect, Jordan (1988) concludes that older people are less accepting for computer based products compare with younger people. Nevertheless among the truck drivers, which tested our services, we didn't find such major differences. One reason may be that finding such differences was not a task in our study. Another reason could be that the population of "testers" was not big enough.

A problem during the field studies, observing truck drivers conducting their work, was in fact our presence. Driving a truck is normally a "lonely type of work", and to study such phenomenon is of course hard. Nevertheless was our presence very welcome in their normal lonely work environment. From that we draw the conclusion that in this "lone wolf type of work environment" they miss the verbal interaction with other human beings.

A product that is usable for one person will not necessarily be usable for others. When designing, you should design for usability, as for example described by Jordan (1988). We tried of course to get as good usability as possible, but it is important to have in mind that the purpose of the design was not to make a design ready for commercialisation. The design should be sufficiently enough to make the end-users, the truck drivers, willing to use such services in the future.

After a few weeks of our study have elapsed, we discovered that designing for small devices was even harder than first anticipated. In conjunction with literature (Kacin), the small screen size, of a PDA, could be very frustrating when you try to add all necessary items on a single screen. Hence, a well-planned disposition of necessary objects and the removal of unnecessary objects are key design factors. We aimed, of course, to do the best possible design of the prototype. At the same time, it is a prototype, and as the name suggests it is not ready for commercialisation. The prototype did not only fulfil the show-window of our design, it also fulfilled another important aspect, as the tool used for testing the truck drivers' interest in our defined services.

At "Bäckebols Åkeri", we used the prototype and tested both the usability of our design and as mentioned above how the defined services would affect the truck drivers in their working environment. As mentioned earlier the reactions were positive and curiosity for this type of services was raised. The test was, however, not conducted in the real working environment and the test persons were working under stress. What would e.g. happen if the device, or the connection between the device and other systems, suddenly stopped working? For all except one of our services there would not be any catastrophe, just inconvenience. *Load Indicator* would still be present in the cabin. They would not be able to detect friends if *Friend finder* is out of order etc. Consignment not is although another issue. In beginning of our thesis, we were of the opinion that the truck drivers should not be dependent of the PDA, since it should only be a helping tool. When deciding that *Consignment notes* should be part of our services, we deviated form the role of the PDA as a "helping tool". It was, however, a good decision since *Consignment notes* turned out to be the service most appreciated. Simply because this service to a great extent facilitate the truck drivers work, and thus most likely be the service most frequently used. Suppose *Consignment notes* became a standard and then suddenly stopped working. This would be a catastrophe, since handling consignment notes is both an important and a major work task in the truck drivers' profession. A solution, to this problem, might be to still use copies of consignment notes (today's situation) as a backup.

The services have not been tested in their “real” environment because of two factors. First of all integration of our services with a computer system within a truck would have been very time consuming, time that we simply did not have. Secondly we had no available truck with such computer system. Nevertheless we don’t believe that this was a major issue since our task was to discover new services and evaluate if these were useful or not.

There is a prejudice that truck drivers and new technology do not comply (Jordan, 1998), but our conclusion is that both “older and younger drivers” will adapt to new technology if they see a major benefit. Younger drivers are also very curious and like to test new technologies they never have used before. They raised questions like; “When are all these services available”?

Introducing our prototype into the "real world" would not be an easy task. A major factor is that our services, especially the *Consignment notes*, would change the truck drivers current work behaviour. Changing behaviour is always very hard. *Consignment notes* would be difficult to implement, since a lot of other diverse computer systems will be involved, and hence the task to get a homogenous service will be hard. Implementing *Consignment notes* would require huge amount of development hours. The PDA must also be accepted by the end-users, and such acceptance will take time. The small screen size of the PDA has to be accepted by the end-user and by the developer, who will have a more difficult task implementing the services. Another problem is that the battery in the PDA frequently needs to be recharged.

We are sure that rapid improvements of the device, both hardware and software, will occur. That means battery capacity and system speed will increase. However, a problem that will be very hard to solve, is the size of the device. One of our test persons said; “it has to be both bigger and smaller”, meaning that the device itself must be smaller but at the same time the screen in which all information is displayed should be bigger. Changing people’s behaviour is, as mentioned, hard, but possible, if a service provides benefits and satisfies end-users needs. Although it usually takes a lot of time but the adoption time will decrease the higher its benefits are.

6 Conclusion and future work

The research problem in this study was:
“What kind of interesting services, used on a PDA by truck drivers in their profession, could be discovered, and how could they be designed?”

We discovered in our field studies, that loading consumes the major part of a truck drivers’ working time. Another major hassle is the administrative work conducted by the drivers, mainly handling of consignment notes. It was also obvious that truck drivers miss social interaction during their working day. It was therefore quite natural to determine and evaluate new services in these areas. The services that emerged were:

- Administration services that included the work with the consignment notes
- Transportation efficiency services that include services to help with the loading,
- Automatic services to lock and light the truck and to make the truck driver pay attention if the truck allocate an alarm
- Social interaction services that make the truck driver have the opportunity to find a friend in the vicinity.

We designed the above services with usability and the end-users, the truck drivers, in mind. Although, it is important to have in mind that the purpose of the design was not to make it

ready for commercialisation. The design was however sufficiently enough to make the end-users willing to use the services. Instead of showing the outcome of the design in the conclusion we refer to chapter 4.5.

A future task would be to develop a full working prototype that would be connected to a computer system in a real vehicle. Since our test persons expressed “Consignment notes” and “Load indicator” as the most interesting services it would be natural to start with those. This would probably give even more objective results especially when also evaluation occurs in driver’s real working environment. The whole application also needs more esthetical design work. Some of the services, such as the alarm service, need long-range connectivity between the vehicle and the PDA, for example GPRS. Another technology that has to be implemented, because of the maps in “Friend Finder”, is GPS.

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8 Appendix 1

8.1 Phases

8.1.1 Determination of the question for research

Do truck drivers have any kind of help from a PDA when working?

8.1.2 Collection of information

In this phase, information will be collected from databases on the Internet, encyclopaedias, journals, etc. The information to be collected is focused on Telematics, existing systems in trucks and already done field studies for truck drivers. Another very important source of information will be own executed field studies, done in places where you normally can find truck-drivers during their working hours and of course to accompany a driver during a working day. Places of interest may be where truck drivers take brakes, where they maintain their truck and where they load/unload the cargo. To spend a working day with a truck driver will probably give a lot of input and will probably be better than spend a shorter period of time with several. In the meantime of the research there can be necessary to do more field studies, i.e. some kind of repetitive behaviour.
Another activity will be brainstorming sessions.

8.1.3 Problem determination

The collected information will during this phase be analysed in order to determine problem areas. The problem areas, i.e. the number of discovered problems, will in this phase also be reduced.

The work procedure to determine the problems includes, formulating the problem and to delimit the problem.

The method to be used, in this procedure, is called “The method of questions” (Hamrin, Nyberg, 1993). By using, a number of questions the methods try to capture important facts and issues that will serve as a base for the final description of the problem. The following type of questions will be used:

What is the problem? Why does it exist?
In which situation does the problem occur? Why can you find it in that situation?
When does the problem occur? Why does it appear in then?
Who is involved? Why is that person or object involved?
What is the frequency of the problem? Why this frequency?
What components does the problem consist of (sub-problem)? Why does this sub-problem exist?

Before specifying the determined problems, the number of problems will be reduced. The reduction will be done using brainstorming sessions and, most importantly, by checking with truck drivers if the discovered problems really exist.
The procedure then continues with “function dividing” where main functions and functions for supports are defined (Hamrin, Nyberg, 1993).

8.1.4 Examination and division of the problem

The problems can be divided in three different ways, *position*, *place*, or *environment*. The intention with this is to make a delimitation of the problem that facilitates the solution for different characters of the environment.

The derived problems will in the phase be examined. The problems will be further analysed and if possible divided into problem areas (sub-problems). The method to be used is called *area division* (Hamrin, Nyberg, 1993), and in particular, the process part will be used, adapted to services since Hamrin & Nyberg discuss mainly products. In other words, our determined problems will be divided into areas based on the different processes that occur during the haulage of goods.

8.1.5 Problem solution

When we have determined and made the examination of the problem the next step is to search for solutions of the problem. Brainstorming is the primary method that is going to be used (Hamrin, Nyberg, 1993). When brainstorming critic is not allowed, quantity is preferred and unusual solutions will be welcome. By using discussions in the own group, with the instructor and probably other involved the number of solutions will be reduced (most likely at least).

8.1.6 Design

In this phase the design work of the "problem solutions" starts. The outcome will be one or several tested design suggestions. Design is a rather creative process and hence no defined method in the literature will be followed. In all the phases above, gained knowledge from the IT-University will be used, but in this phase this knowledge will be even further necessary. Relevant case and articles studies in the design course will be used. We will also search for additional design articles that might help us in the design work. Other sources of information will primarily be the Internet.

The tools to be used will be, relevant software, pen and papers, post-it-notes etc.

8.1.7 GUI Testing

As your team establishes new designs to address your mobile work force, you need to move beyond the situation of having each developer promote a particular opinion on interface design styles and instead validate your decisions with formal
usability testing. This process will provide a statistical and factual basis for you design decisions and more adequately ensure that your design will be successful when deployed in the field (James Hobart, 2001).

Respondent

In the latter part of this phase, the design will be tested on people working at Volvo Technology Corp in order to find the best solution/solutions.

Managing Risk with usability Testing

Performing a study with a small number of users can be a cost-effective way of minimizing the potential risks of development and launching unusable software or web interfaces. If the participants for the tests are carefully selected, the study is appropriate designed and executed, and the data is analysed methodically and accurately (Rosenstein 2001).

8.1.8 Prototype Development

In this phase a prototype of design, suggestions will be done and for the development, UML implementation will be used. Due to time limitation, we will not use all parts of the UML process. We will write Use Cases, class diagrams and sequence diagrams. All this on a rather high level due to time limitations as mentioned before.
The implementation will be done in either C++ of Java.
The functionality of prototype will be repeatedly tested throughout this phase. Since we are two persons implementing, we will test each other's implementation.
The outcome of this phase will be one or more ready for beta test (test carried out by others than the developers).

8.1.9 Usability testing (Prototype test)

In this phase, the prototype will be tested and evaluated in order to see if our "research question" has been answered.

The developed beta-prototypes will in this phase be tested by employees at Volvo Technology Corp and of course our instructor. If severe bugs are found, the prototype development phase will start again and a new beta version will be made. Then test starts all over again. This will be repeated until sufficient working prototypes exist.

The next and very important task will be to evaluate the prototype. The evaluation will be done by letting truck drivers use the prototypes in the environment they are aimed for.

Finally, the evaluation result will be discussed with the instructor to verify that the "research question" has been answered.

8.1.10 Sum up

In this phase, the thesis report will be finalized.
The thesis work will also be presented for Volvo and the IT-University.

9 Appendix 2

9.1 Form of design test

The test person should solve those following tasks by using slips of paper, as it was real application on a PDA.

9.1.1 Introduction

This GUI-test has as its aim to test person gets different tasks he/she will try to solve. There are some explanations below you should read before testing starts.

9.1.2 Explanations

Load Indicator – measures load weights.
Consignment notes – digital form of consignment notes.
Driver's manual – driver's help of assistance.
Friend Finder – an application that detects friend in vicinity.
Settings – this is to set wanted settings.

9.1.3 GUI test

- What is the front-axle load on the tractor?
- Go back to the main menu.

Scenario: You are loading your truck and get a warning message on the screen with a warning sound.

- What axle is overloaded?
- How much is it overloaded?

There are 4 lists of consignment notes.

- Scroll through the list with delivered goods.
- Which products will be delivered to "Din sko"?
- Change the role to the receiver who works for "Din sko" and sign for received goods.

- Add a friend to "my friend-list" so you will be able to see him/her when you are near one another other.
- Open the map to see where your friends are.
- Make yourself invisible for your friends.

- Go to settings for "Keyless entry" and change the distance, where "Keyless entry" will be activated, to 20m.
- Put a cross for all three services that will work with "Keyless entry" (Alarm, Autolock and Approach lights).

- Turn the lights on manually.

  Scenario: You are leaving trucks coverage area.
- Tell us what happened by comparing start menus inside and outside that area.

10 Appendix 3

VOLVO LOAD INDICATOR