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Surf the roads?

– An interview study aiming to investigate truck drivers' needs for a web browser in the truck cab.

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Abstract

Long haul drivers spend a lot of time in their trucks which consequently serves as both a work place and a second home. The Internet, and communication and information technology can be used for both personal uses by the drivers, and lead to major savings for the haulage firms and provide high level service to the customers. This study investigates what needs long haul drivers have for using the Internet in their trucks, and which device that best would suit their needs. A questionnaire study was held including 35 drivers, and an interview study including 30 drivers. The results show that almost all drivers want to perform work related tasks through the Internet, and several of them also want to use personal applications online. Work tasks online needs to be performed during the day, whereas private use of the Internet mostly would take place at nights. Several drivers are positive to an integrated system for using the Internet in the truck, and the study presents a possible concept for such a system, and discusses the results related to present research and applicable theories.

Keywords: Long haul drivers, truck, the Internet, Joint Cognitive Systems, control, needs, goals-means, interviews, personas, concept

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1 Introduction

Trucking transports currently accounts for 95 percent of the value of all goods shipped within the EU (TYA, 2011). The demands from consumers and companies are high on people working in the transport industry today. The deliveries are expected to be quick, flexible and effective and the transport vehicles that manage these demands the best are the trucks (TYA, 2011). But to be able to meet the high demands a truck is not enough, the truck drivers have to settle in on the high demands as well. One way of doing so is to spend a lot of time away from home in their trucks. To drive long distances, in different continents and different countries, and to stay away from friends and family during long periods of time. Many truck drivers both work and live in their truck big parts of the year and there are many of their daily needs that still have to be fulfilled. It's both work related needs and private needs, like being able to contact friends and family, search for information and so on. Many of these things could be done through a web browser. So, the focus of this thesis is to find out what needs truck drivers have of a web browser in their trucks, what device a web browser should be used through, where it should be placed, and what it should be used for.

1.1 Aim

Information technology and the Internet can ease many work tasks. Truck drivers spend a lot of time away from home, many of them sleeping in their truck several nights per week. A web browser is an effective tool for finding and sending information, keeping contact with family and friends etc. The aim of the study is to find out what needs long haul drivers have for using the Internet in the truck cab, and what kind of device they'd like to interact with to use the Internet.

1.2 Research Questions

The research questions are divided into two main questions, about what *needs* long haul drivers have for a for using the Internet in the truck cab, and what kind of *device* that's best suited for their needs of using the Internet on in the truck cab.

- What are long haul drivers' needs for a web browser in the truck cab?
 - What fields of applications of a web browser do they need?
 - In what situations do they want to use a web browser?
 - Are the needs different for work related uses and private?
- What kind of device is best suited for long haul drivers' needs for using the Internet in the truck cab?

- How should the interaction with the device go about to best suit the driver's needs?
- Where should the information be presented?

1.3 Limitations

The study comprises only long haul drivers working in Sweden. Therefore, it is not possible to say whether the result is true for drivers working in other countries or driving other types of trucks. The concept developed in this study is based on interviews with 30 drivers, but there has not been any opportunity to make user tests on the concept with the drivers afterwards.

1.4 Outline

The thesis continues below with a presentation of the background of truck driving profession and technology in truck cabs (Chapter 2). After that the theoretical background that has been used as a basis for the study is presented, Joint cognitive systems (JCS) and Kano's model of needs (Chapter 3). The next chapter contains a description of the method used in the study (Chapter 4), and after that the results and analysis is presented (Chapter 5). The last two chapters contain a discussion of the research questions in relation to the results and the background (Chapter 6), and the conclusions (Chapter 7).

2 Background

World's first truck was built by the German company Daimler in 1891 and the first Swedish truck was built in Södertälje in 1902 by *Vagnsfabrikaktiebolaget* (Vabis) (Nationalencyklopedin, 2011).

The part of trucking industry that includes long haul driving and overnight stays in the truck is not a very old phenomenon. Drivers have had this sort of work for only about 60 years (Nehls, 1999).

2.1 Trucks

Trucks can be divided into light trucks and heavy trucks. A light truck has a total weight of at most 3.5 tons, and a heavy truck has a total weight at over 3.5 tons. In Sweden heavy trucks can be driven at a speed of up to 90 km/h on the freeway and up to 80 km/h on other roads. A truck with trailer breaks can be driven at a maximum speed of 80 km/h at any road (Nationalencyklopedin, 2011).

As a truck driver you can have many different work tasks. For example you can work as a long haul driver, a driver of construction, environment or forest transport, or as a driver of hazardous cargo (TYA, 2011). The section below describes a common work situation for long haul drivers.

2.2 Work tasks and work situation

As a long haul driver you can either both own and drive your own truck, or you can be working for a haulage firm. When working for a hauler it is preferable among the drivers to always drive the same truck, because it increases job satisfaction. In both cases you drive long distances and stay away from home for extended time periods. When driving for a hauler it is common to not know exactly where you are going until just a few moments before actually starting to drive. When the driver gets his destination and the truck is loaded the driver himself is free to plan the route. To keep track of the bill of carriage and the papers of the unloading arrangements and to arrive on time to customers is very important. The profession is based upon trust and freedom with responsibility. If the truck driver has a family at home it is important to find a functioning solution since a truck driver doesn't have normal working hours and often stays away from home for several days in a row. Working as a long haul driver you get to see and experience many things and different cultures. For example a long haul driver can travel through several countries and visit many different companies during one day. It is an advantage to know which roads to take to avoid getting stuck in traffic. To have good social skills and to be nice to the customers where loading and unloading is also important since it gives the driver benefits the next time he comes to the same customer. When the driver has visited all the companies in the unloading arrangements the driver contacts the dispatcher to get a new destination. To get this

information from the dispatcher may take a few minutes up to several hours. It's also possible that the driver receives a new order on the way back home, which means that the driver can't be totally sure of the arrival time back home (Nehls, 1999).

2.2.1 Job skills

According to Nehls (1999) both truck drivers and haulers consider a truck driver's job skills as having good social skills, being responsible, and being able to complete the assignments within the predetermined time limits without any damages on the goods transported. Many of the people working in the transport industry don't even mention the ability of driving the truck as a job skill, since it is taken for granted as an ability of any truck driver. To be on time is also important when it comes to the strict driving and rest time rules, described below.

2.2.2 Driving and rest time rules

The driving and rest time rules are determined by the EU regulation in case the truck has a total weight of over 3.5 tons. Each truck covered by the regulation must have a tachograph installed that record the drive and rest times. Trucks that were put into commission after April 30th 2006 must have a digital tachograph installed (Åkeriföreningen Syd, 2010).

The rules are based on a 24 hour period, and during this period the rules must be followed and the amount of rest must be enough for one day and one night. If a driver drives for 4 hours and then rest long enough for the daily rest, then a new 24 hour period starts. Each day the daily amount of driving time is allowed to be up to 9 hours. However, the daily driving time can be extended to 10 hours at a maximum of two times during one week. Driving time during one week shall not exceed 56 hours. The total driving time during any two consecutive weeks shall not exceed 90 hours (Åkeriföreningen Syd, 2010).

2.2.2.1 Rest

When driving for 4.5 hours the truck driver must take a break of at least 45 minutes. This break may be replaced by a break of 15 minutes, followed by a break of 30 minutes provided that the driver does not drive more than 4.5 hours before the next break of at least 45 minutes (Åkeriföreningen Syd, 2010).

2.2.2.2 Daily and weekly rest

The driver have to take daily rests for at least 11 hours every day, either 11 hours in a row or divided into one rest period of at least 3 hours and another one of at least 9 hours. Every week the driver has to take a weekly rest of at least 45 hours consecutively (Åkeriföreningen Syd, 2010).

According to Nehls (1999) truck drivers try to plan their driving in a way that most efficiently takes advantage of the rules. Many drivers also feel that the rules sometimes can be a stress factor, but overall they think it's good that the rules exist as a safety measure.

2.2.3 Food and rest stops

Working on the road you don't have much access to cooking facilities. Many truck drivers eat nearly all of their meals inside the truck. They bring sandwiches and simple meals in the refrigerator underneath one of the sides of the trailer. They often keep water bottles and sometimes a coffee maker inside the truck cabin, and they usually stop for at least one meal a day at a truck stop. It's common that truck drivers gain weight when driving abroad (Nehls, 1999).

Many drivers think it's important that the rest stop they choose to stop by has got a nice and clean toilet and shower that they can use (Nehls, 1999).

2.2.4 Socialize

The place where truck drivers most likely meet and socialize is on the ferry, since they park their trucks at the same place and can get out and talk to one another. They can discuss the best road to choose to a specific destination, the unloading arrangements, how to treat different customers and talk about beautiful places they've been to and places they would like to go to. But many drivers only tell their best advices about good paths, or other things that could ease the work, to their best friends and colleagues, or just keep it to themselves (Nehls, 1999).

Nowadays it is not as simple as earlier to plan when and where to meet other truck drivers on the journeys. Since the introduction of the EU-rules it's easier to pass the borders which mean that the social life during the waiting times is lost. When the drivers stop at a rest stop they can almost never be sure to meet anyone they know, it's pure chance. This was easier to plan before the new driving and rest time rules were introduced (Nehls, 1999).

In the cabin there is a communication radio which sometimes is used to talk to other truck drivers, or sometimes just to listen to conversations between other drivers. The drivers can also call a colleague on the cell phone to ask for advice on which route to take, or where the company they're driving to is located (Nehls, 1999).

2.3 Long haul drivers

Long haul drivers are the largest group of drivers in the trucking industry, and the drivers spending the most time in their trucks (Nehls, 1999). Since this study aims to investigate the needs for using the Internet in the truck the study has been focused on long haul drivers because of their extensive time in their trucks. One of the common trucks used by long haul drivers is the Volvo FH-truck.

2.3.1 Volvo FH

Long haul drivers most often drive a truck with an FH-cabin. FH means that the cabin is covering the entire engine and needs to be tipped forward at service, installations or repairs.

FH also refers to cabins that have a high step. There are many different types of FH-cabins and the ones most used by long haul drivers are the long cabin, LH (sleep cabin) or the long and high cabin, LHH (Globetrotter) since they have overall larger space and space for one or two beds. The LHH has the most space and is usually used for very long journeys (Volvo Truck Parts AB, 1991).

2.4 Technology in truck cabs

During the last decade the trucking industry has gone through some big changes affecting supply chains and logistical processes. One change is companies' inventory reductions, which led to "Just in time" purchasing, and the "Efficient consumer response", which is the just in time refilling of goods in the retail industry. These changes have led to new challenges for the trucking industry, and for truck drivers, which can be supplied by introducing new information technology in the trucks (Roy, 2001, Golob & Regan, 2005).

The last decade information and communication technology available to drivers have grown significant, and the development process is driven by customer demands (Stevens, 2000). Information technologies like Electronic Data Interchange (EDI), the Internet, Global Positioning Systems via satellite (GPS), and Decision Support Systems (DSS) can significantly enhance the planning capability of the transportations (Roy, 2001).

Some of the benefits from using information and communication technology are; minimization of manual data entry, increased transaction speed and accuracy, lower communication costs, and encouragement of simplification procedures (Roy, 2001). Other benefits are the efficiency of goods movement (Golob & Regan, 2005), and the ability to receive information about the external environment (Stevens, 2000).

2.4.1 Driving safety

Information and communication systems can reduce the drivers' uncertainty and stress, and potentially contribute to safety. However when designing in-vehicle systems attention must be paid to how the systems are actually being used by the drivers, to prevent developing systems that can negatively affect the driving behavior by distracting attention from the driving task (Stevens, 2000).

Every time a new system is installed into a vehicle it may have implications for safety, whether or not it was designed to improve safety, since it has the potential to change the existing relationship between the driver, the vehicle, other road users, and the road environment (Stevens, 2000).

In 1998 a European Commission Task Force including a small group of experts including Stevens (2000), developed a list of principles that should be applied to driver information and communication systems used by drivers while driving (Stevens, 2000). The principles concern the; 1) *Overall design*, which should support rather than distract the driver, 2)

Installation, the system should be located according to regulations and standards, should not obstruct the line of sight and should avoid glare and reflections, 3) *Information presentation*, the information should be presented in a clear and simple form, and be appropriate, accurate and timely, 4) *Interaction with displays and control*, the driver should be in control of the interaction and still attend to the driving task, 5) *System behavior*, it's important to investigate what parts of the system that should and should not be accessible while driving, 6) *Information about the system*, the driver should have access to all necessary information about the system (Stevens, 2000).

2.4.1.1 Telephone use in vehicle

According to Stevens (2000) the most unsafe part of talking on the phone while driving is the dialing part, since the use of buttons results in divided attention and changes in the direction of vision.

Mobile phones would probably not be a significant factor in accidents if one could somehow ensure that; 1) Phones were only used in light traffic, 2) Drivers did not initiate calls unless the numbers were preprogrammed, 3) Only routine/casual conversations were held, 4) Calls were kept brief, 5) The drivers used well-designed hands-free kits (Stevens, 2000).

2.4.2 On-board computers

On-board computers used in the truck cabs make the work more efficient for both truck drivers and haulage firms. The staffs at the haulage office can through information from the on-board computer see the location of the trucks, and modify work scheduling and the load planning of the firm's vehicles which both results in major savings and provides high level service to the customers (Roy, 2001). The on-board computer is used to forward customers' requests (i.e. driving orders) from the office to the truck. The driving order information is registered in the carrier's information system (CIS), and displayed to the truck driver on the screen of the on-board computer. When loading or unloading the driver sends information through the on-board computer back to the office to update his status (Roy, 2001, Golob & Regan, 2005).

As early as in the beginning of the 90's a survey study with 200 managers of logistics and transportation companies in the United States showed that information and communication technologies were the most important factor of success in their business (Roy, 2001).

The on-board computer also works together with a tacograph that keeps track of vehicle speed and the driver's work and rest hours, in order for the driver to act in accordance with the laws and regulations (Roy, 2001).

2.4.3 Satellite positioning

Satellite positioning through satellite communication is used to give the office of the haulage firm information of where each truck is located. This enables the office to provide up-to-date

information to customers based on the exact position of the goods. The satellite positioning also makes the dispatch planning easier for the office, and makes adaption for unforeseen changes possible (Roy, 2001, Golob & Regan, 2005).

2.4.4 Dynafleet

Dynafleet is a web based transport information system by Volvo Trucks, and is a type of on-board computer described above. It consists of information on where the truck is located in real time, information on fuel consumption, messages, driving times, service intervals etc. The system can be integrated with the administrative system at the haulers office (Volvo Trucks Sweden, 2011).

Dynafleet works between a computer with internet connection at the office and a hardware unit installed in the truck, and a combined GPS-/GSM-antenna. The hardware is connected to a screen in the truck cab (usually a 7 inch screen), and might also be connected to a keyboard. The driver can also get access to the Internet through the system (Volvo Trucks Sweden, 2011). To get access to the Internet the system unit in the car needs an USB-port and an IP-port, and the telematics solution is used as a modem. It is a 2G connection.

Through the computer at the office the hauler can send text messages to the driver's screen in the cab, and the hauler can get information about the driver and the truck back to his computer (Volvo Trucks Sweden, 2011). The communication between the driver in the truck and the hauler at the office works through the GSM-network. The screen is placed in or above the dashboard (Volvo Truck Corporation, 1998).

The transport purchaser can log on to *Dynafleet Online* to get information on where the truck carrying its goods is located in real time, when it was loaded, and the estimated delivery time (Volvo Trucks Sweden, 2011).

Dynafleet is developed for the Volvo's FH and FM trucks but can be used in any type of truck, although the functionality might be somewhat reduced depending on types of tacograph, different electronic systems etc. (Volvo Truck Corporation, 1998).

2.4.4.1 Controls

The driver interacts with the Dynafleet system through a keypad placed on the dashboard next to the steering wheel. The keypad consists of a select button, an escape button, and the four arrows in the directions up, down, right and left. A keyboard can also be used and works through an IR-signal. The IR transmitter on the keyboard must be directed towards the IR receiver on the Dynafleet unit when the driver types a message. The keyboard can only be used when the truck is standing still (Volvo Truck Corporation, 1998).

2.4.4.2 *Standard menu*

The standard menu of Dynafleet consists of the titles *Mail*, *Drive/Rest time*, *Orders*, *Log*, *Emergency & Assist*, *Settings* and *Turn off*. The driver chooses between the titles by moving the cursor to the desired title using the arrow keys and chooses it by pressing the select button (Volvo Truck Corporation, 1998).

2.4.4.3 *Mail*

In the *mail* menu the driver can receive, manage and send messages. The driver can also get information from his address book in this menu (Volvo Truck Corporation, 1998).

2.4.4.4 *Drive/Rest time*

The function *Drive/Rest time* works together with the tacograph in accordance with the EU's driving time regulations. It's used for the driver to be able to follow the rules. Dynafleet collects information from the tacograph which makes it possible for the driver to see information on driving time, rest time, work time and waiting time. When the truck is in motion the activity is logged from the tacograph as driving time in Dynafleet, and when standing still the type of activity logged depends on the settings in Dynafleet. The system keeps track of the different activities and if any time regulation is about to be broken a warning message is displayed at the screen (Volvo Truck Corporation, 1998).

The driving time data is sent to the office through the GSM network. Each driver has an individual driver card which is placed in the digital tachograph to separate the different drivers' data from one another (Volvo Truck Corporation, 1998).

2.4.4.5 *Orders*

When the driver gets a new *order* through Dynafleet he can see information on; the goods, the place, the status of the assignment, the planned arrival time and the planned departure time. The driver can accept or reject the order, and can also report to the office on the progress of an order (Volvo Truck Corporation, 1998).

If the driver has a compatible navigation device in the truck it can be connected to the Dynafleet unit. If an accepted order contains position information it can be sent to the navigation system from the Dynafleet unit (Volvo Truck Corporation, 1998).

2.4.4.6 *Log*

In the *log* menu the driver can get all saved data from the different logs. The data shows vehicle information such as fuel consumption, distance, etc., temperature, and driver coaching if selected. The driver coaching gives pop up information with guidelines on how the driver can improve fuel consumption (Volvo Truck Corporation, 1998).

2.4.4.7 *Emergency and assistance*

In the *emergency and assistance* menu the driver can type a message of assistance request, and see the status for sent assistance and emergency requests. The driver gets a pop up window with information when the request gets new status. The status shows; amount of time since the request has been initiated, time received by office, time it has been attended to, and the requesting driver name (Volvo Truck Corporation, 1998).

2.4.4.8 *Settings*

In the *settings* menu the driver can adjust different system parameters like language, units, volume, brightness etc. (Volvo Truck Corporation, 1998).

2.4.4.9 *Emergency assistance button*

In the dashboard or on the radio shelf there is an *emergency assistance* button which sends an emergency message if pressed for 3 seconds. The message is sent either to the office and to VAS (Volvo Action Service), or to Security Services. Messages will appear on the screen informing the driver on ongoing emergency request status updates (Volvo Truck Corporation, 1998).

2.5 Needs for the Internet

In a study by Golob and Regan (2005) 712 haulage firm managers in California evaluated the importance of nine types of information that truck drivers might receive or send using the Internet through an in-vehicle or hand held wireless device. The nine types of information were *e-mail, delays at US-Mexican border crossings, travel times on alternative routes, weather, train arrivals at grade crossings, delays at terminals and port facilities, port and rail terminal clearances, port and rail schedules, and locations on freeway incidents and lane closures*.

The information evaluated as most important among the greatest number of managers were *locations of freeway incidents and lane closures, weather information, and travel times on alternative routes*, the information on *delays at US–Mexico border crossings* was evaluated as least important (Golob & Regan, 2005).

3 Theoretical background

In this part the theoretical background that has been used as a base for this thesis is presented.

3.1 Joint Cognitive Systems - JCS

Cognitive Systems Engineering (CSE) was formulated almost thirty years ago by Hollnagel and Woods. The goal of CSE is to describe and evaluate humans and machines working together, as a Joint Cognitive System (JCS), and to design JCSs in a way which makes it possible for the systems to effectively control the situations where they have to function (Hollnagel & Woods, 2005).

The machine part of the JCS is defined by Hollnagel and Woods as any artifact designed for a specific use, and the human part in the system is usually referred to as an operator rather than a user. The system is arranged to achieving specified goals. A JCS always consists of at least one human, but it can also be a group of people, and it can be in combination with different artifacts (Hollnagel & Woods, 2005).

The focus of JCS is on joint system performance. According to Hollnagel and Woods (2005) it is important to know how the parts in the system *communicate*, but it is of even greater importance how the joint system *performs*, and how it can achieve its goals and functions effectively. Even though humans and machines are *physically* separate they should not be seen as *functionally* separate. Hollnagel and Woods compare the JCS to a group of people that constitute a team. It is the performance of the whole team that counts. The performance of the team is more important than the performance of a single person in the team. The teamwork and congruence of the components of the system is what's most important.

JCS is based on an integrated view of how human and machine effectively can work together. The focus is changed from the interaction between humans and machines to human-machine *coagency* or joint agency. Hollnagel and Woods use the word agency to describe the state of being in action or how to reach a goal. The focus lies on what a system does, rather than what it is. The *what* (the performance) is more important than the *how* (Hollnagel & Woods, 2005).

A human using an artifact is a type of a JCS. Artifacts themselves affect human performance and how the world is seen, which is why one should focus on how the human-artefact ensemble performs, instead of how humans interact with artefacts (Hollnagel & Woods, 2005).

3.1.1 Function allocation

Function allocation is the determination of which functions in a system should be performed by humans, and which should be performed by machines to achieve a common goal. *Human-centered automation* principle is a way to try to resist the negative effects that sometimes autonomy performed by machines can bring, e.g. out-of-the loop performance problem, loss of situation awareness, and overtrust. The approach of human-centered automation is to develop work environments where human and machines collaborate, but where the human must be in command (Inagaki, 2010).

Studies by Inagaki have proven that under some conditions better results are reached when the machine is given authority for decision and control, than the case when the human is always in command. This approach is called *situation-adaptive* autonomy and means that the human and the machine trade authority dynamically depending on the situation, also called *adaptive automation* (Inagaki, 2010). This approach accord with the theory of JCS (by Hollnagel and Woods) which is saying that humans and machines collaborate together to achieve common goals. When realizing that human and machine strive for the same goals, and have own limitations, it does not make sense to assume that the human must always be in control (Inagaki, 2010).

3.1.2 Goals-means analysis

The analysis and design of a JCS must start by analyzing the functions and activities that may take place when the system is in operation. A function analysis can be based on a distinction between goals and means, a goals-means decomposition. A goals-means decomposition does not require any prior assumptions about the nature of cognition or about what the primitive processes are (Hollnagel & Woods, 2005).

To describe a system in terms of goals and the functions needed to achieve them (means), is to adopt a top down rather than a bottom up approach. The best possible candidate for a top down analysis principle is the goals-means method (Hollnagel & Woods, 2005).

To understand how a JCS works models should be at the level of meaningful system *behavior* rather than at the level of the underlying processes. Modeling therefore cannot be of cognition alone but must be of cognition and context as a whole, or in other words of coagency (Hollnagel & Woods, 2005).

Artefacts are not just passively used, but do also themselves have a significant effect on human performance and how the world is seen. The consequence of that is that we need to go beyond describing how humans interact with artefacts, and instead consider how the human-artefact ensemble performs, i.e. the issue of JCSs (Hollnagel & Woods, 2005).

3.1.3 Context

Systems, and also JCSs, must be understood in the context where they occur, since the JCSs are affected by the environment, and may also affect it. To be in control the system must maintain control in an unpredictable environment (Hollnagel & Woods, 2005).

Something is called a system if it is seen relative to an environment, and separated from this by a boundary. The boundary is defined by the fact that it makes sense in relation to the purpose or goals of the JCS, to consider the JCS as a unit. Objects are concluded in the JCS if their functions are important for the ability of the JCS to maintain control, and can be effectively controlled by the JCS (Hollnagel & Woods, 2005).

The distinction between the JCS and its environment is important in two different ways. First it is obviously important that a distinction is made since without it it's unclear what the system really refers to. Also it's important to realize that this distinction is relative rather than absolute, i.e. the boundary is defined according to a set of criteria that depend on the purpose of the analysis, hence on the system's function rather than its structure (Hollnagel & Woods, 2005).

The environment imply the objects that affect the JCS if the objects attributes change, and also objects whose attributes are changed by the behavior of the JCS (Hollnagel & Woods, 2005).

3.1.4 Goals

Since a JCS always consists of at least one human, the goals of a JCS are often the same as the goals of the human part of the system. A JCS tries at all times to choose the actions that will achieve its goals (Hollnagel & Woods, 2005).

3.1.5 Control

The ability to *be in control* is an important part of what a cognitive system is. To be in control is by Hollnagel and Woods (2005) defined as the ability to achieve a desired outcome, reach desired goals, and to prevent unwanted outcomes. Also it's about the ability to sense a difference between actual and intended state, interpret it, and to compensate for the difference. The system must be able to keep control both under normal circumstances and when something unexpected happens (Hollnagel & Woods, 2005).

Another significant feature of being in control is the feed forward control, the ability to make predictions. To make predictions the system must be able to *generate possible alternatives, distinguish alternatives in relation to current objectives, and evaluate and choose the most appropriate alternative*. The machine part of the JCS can support the generation of alternatives, since it quicker than a human can find different solutions. When it comes to the distinction of alternatives the human is needed since the distinction task doesn't demand the speed of a computer, but the decision making of a human to find an appropriate criteria.

To choose the best alternative is beyond the capabilities of a machine, and is left for the human to do. To consider the three capabilities of feed forward control together is to apply the JCS and coagency perspective (Hollnagel & Woods, 2005).

A number of common conditions characterize how well a JCS perform, as well as when and how it loses control. These conditions are *lack of time*, *lack of knowledge*, *lack of competence*, and *lack of resources* (Hollnagel & Woods, 2005).

3.1.6 Complexity

When striving for higher efficiency in a system a common result is increased complexity, which unavoidably brings the system closer to the limits for safe performance. To refute larger risks it's common to apply different automated barrier functions and safety and warning systems. Automation is according to Hollnagel & Woods (2005) the execution of a function by a mechanism or a machine, which was previously executed by a human. The application of automated barrier functions and safety and warning systems often leads to even more complex systems, which in turn leads to even bigger overall risks. It may be that the amount of accidents remains the same but the consequences of accidents get larger.

3.1.7 The driving task explained by ECOM

The Extended Control Model (ECOM) describes how the performance of a JCS takes place on several layers of control simultaneously (Hollnagel & Woods, 2005). Hollnagel, Nåbo and Lau (2003) have used this principle to describe the driving task, with the driver-vehicle as a JCS, and with multiple, simultaneous control loops.

By using the ECOM model it's possible to describe how disturbances may spread between control levels. It's also possible to evaluate new functions in a system at the specific level that they are aimed to be used (Hollnagel et al., 2003).

A model of multiple layers of control is needed to explain the task of driving since multiple goals must be attended to at the same time while driving. Many studies have shown that driving includes a combination or hierarchy of different tasks. The model also explains how control and performance can change from one level to another, and exist on several levels at the same time (Hollnagel et al., 2003).

The ECOM model describes driving by means of four different levels of control called *tracking*, *regulating*, *monitoring*, and *targeting*. The control loop at the *tracking* level consists of the activities required to keep the JCS inside determined performance boundaries. It can be boundaries of safety or efficiency. The activities at the tracking layer have very much to do with closed-loop control, or feedback control (Hollnagel & Woods, 2005). When it comes to driving the tracking layer consists of keeping the speed limit, keep a safe distance to other cars etc. For skilled drivers these activities are performed automatically. If the circumstances change the tasks at the tracking layer can demand more

effort and be more of a task at the regulating level. Goals and criteria for activities at the tracking layer are given by the regulating layer. Many activities at the tracking layer can be replaced by automation. When it comes to driving, cruise control and adaptive cruise control can maintain the speed of the vehicle and the distance to other cars (Hollnagel & Woods, 2005).

The *regulating* layer is the layer which sends actions and input in form of new goals to the tracking layer. The regulating activities themselves are often closed-looped, but can imply preventive control as well. They are not performed automatically but require attention and effort for a short time period. When it comes to driving activities at the regulating layer are for example the positioning of the car relative to other traffic elements, like avoiding obstacles and relative positioning while overtaking. Depending on the circumstances the regulating loop may cut off the tracking loop, if goals in the regulating level are more important. The goals at the tracking level can later be reactivated. The activities on the regulating layer come from plans and goals at the monitoring layer (Hollnagel & Woods, 2005).

Activities at the *monitoring* layer are mainly about setting goals and activating plans for actions. Monitoring activities in the car are for example monitoring the condition of the vehicle, like the fuel reserve. Another example is to monitor the location of the vehicle relative to reference points in the environment. Activities at the monitoring layer can also be about infotainment and information sources. The latter two activities have nothing to do with the actual driving task, but may affect the ability to drive (Hollnagel & Woods, 2005).

The fourth layer is the *targeting* or goal-setting layer, in which when it comes to driving, the destination is determined. The destination goal leads to many sub goals and activities. Some of these can be automated or benefited by information technology. Goals for acceptable performance are also set at the targeting layer. If the circumstances are changed, for example if the destination will be reached too late, the acceptable performance on the other layers may be changed. The performance of speed on the regulating layer for example may be changed and a higher speed might be accepted to be able to reach the goal. It may also lead to greater risks. Goal-setting at the targeting layer is an open-loop activity, since the assessing of a change relative to the goal is not based on just feedback, but on a loose assessment of the situation (Hollnagel & Woods, 2005).

To summarize the four layers; the *tracking* layer consist of actions that are performed quite automatically, without attention, i.e. skills. The *regulating* layer consists of actions of a short duration, which require attention for a short time. At the *monitoring* layer are activities that go on occasionally as long as the task last, the distribution of these activities can be irregular, depending on demands. Actions at the *targeting* layer are almost always about preparation of tasks, and take place every now and then. The ECOM model shows that all four loops of

control are active at the same time, goals and objectives at different layers are being strived for simultaneously (Hollnagel & Woods, 2005).

3.2 Kano's model of customer needs

Today the voice of the customers (VOC) gets more and more focus in product developing, to get the customers satisfied with the finished product. The Kano model is used to identify product attributes that will satisfy customer needs, and is a well-used tool by many product developers (Ullah & Tamaki, 2010).

The Kano model divides product attributes into five different types depending on how well they fulfill customer needs (Gregorio & Cronemyr, 2010). The different attributes are; *must be*, *one-dimensional*, *attractive*, *indifferent*, and *reverse*. A *must-be* attribute is an attribute whose absence in the product cause absolute dissatisfaction in the customer. An attribute is called *one-dimensional* if its realization helps increase the satisfaction, and vice versa. An attribute is *attractive* if it increases the satisfaction although it is not expected to be in the product. An *indifferent* attribute's presence or absence does not contribute much to the satisfaction on the customer. An attribute is called *reverse* if its presence or absence causes dissatisfaction (Ullah & Tamaki, 2010). These attributes are also called the "Kano customer need categories" since they affect how well the customers' needs are fulfilled, and how satisfied the customers will be with the product (Gregorio & Cronemyr, 2010).

Since the attributes correspond to the customers' needs, what's important to remember in the design process is to; keep the *must-be* attributes, add several *one-dimensional* and *attractive* attributes, avoid as many *indifferent* attributes as possible, and avoid all *reverse* attributes (Ullah & Tamaki, 2010).

4 Method

The method is based on the goals-means analysis used in the JCS theory (Hollnagel & Woods, 2005). To find the truck drivers' goals questionnaires and interviews were conducted.

To achieve the aim of the study, and to find out what needs truck drivers have for using the Internet in the truck cab, a questionnaire and an interview study were conducted. Both studies were conducted near a restaurant at a popular rest stop for truck drivers.

4.1 Methodological background

Background for the methods used in the study is presented below.

4.1.1 Goals-means analysis

To design a human-machine system some way of determining how tasks and functions shall be distributed and assigned is required (Hollnagel & Woods, 2005). To be able to determine this, an identification of *which* tasks and functions that's needed for the system to reach its goals is first required. For the design of a JCS it's important to find the functions needed for the system to both reach its goals and to maintain control. A method to do all this is to use a goals-means analysis, which principle is to find the difference between the current state and the goal state and to investigate what functions or means are needed to eliminate the difference (Hollnagel & Woods, 2005).

4.1.2 Personas

Personas are often used to present a typical future user of a new product, so that the design team can understand the user's needs and how to develop the new product. Personas are useful tools since they activate human's natural way of modeling other people's knowledge and mental states, i.e. Theory of mind. Personas are a good way of presenting research data, since most people don't naturally reason about extensive statistical summaries, but we often reason about both real people and fictional people, like the people in a movie or soap opera (Grudin, 2006).

4.1.3 Scenarios

A scenario is a written description of how a certain user uses the future system, and is according to Löwgren and Stolterman (2007) a fast and accessible way of contributing to the formation of a design. A scenario is a very flexible way of formatting a design idea and can be written at any level of detail. Advantages using scenarios are that; the users in the scenarios can be described based on field studies, and the use situations can be fictive but very trustworthy and vivid, and that it is easy for everyone to understand (Löwgren & Stolterman, 2007). The scenarios in this thesis will focus on the users and the functions needed to reach the system's goals, and not go in to details of the underlying processes.

4.1.4 Function analysis

Function analysis is a method of interaction design used by Löwgren and Stolterman (2007). It's used to show *what* the future system is going to do (i.e. what functions it's suppose to have), but not *how* it's going to do it. The different functions are classified as necessary, desirable, or unnecessary (Löwgren & Stolterman, 2007).

4.2 Participants

The drivers that participated in both the questionnaire study and the interview study were all male drivers with different length of experience of truck driving. 35 men participated in the questionnaire study, and the mean age of the participants was 40.7 years. 30 men participated in the interview study, with the mean age of 45. 4 of them owned their own car and had their own haulage firm, and the remaining 26 were driving for a hauler. The size of the haulage firms they worked for varied from 5 cars up to 150 cars.

4.3 Material and Design

This part describes the material and design used for the questionnaire study and the interview study.

4.3.1 The questionnaire study

The first step in the study was to find the most important and most needed fields of applications for the Internet in the truck cab, which was done through a questionnaire study. In the questionnaire study the interviewer was standing outside the restaurant at the rest stop, asking people who stopped by if they were truck drivers. The ones who were, and who wanted to participate got a questionnaire, which they brought in to the restaurant, and leaved it back once they were finished at the restaurant and had filled out the questionnaire.

The questionnaire started with some short demographic questions, followed by three pages where 23 different fields of applications of the Internet were listed. Below each field of application there was a likert scale on which the participants should circle a number from 1 to 6 to indicate how important they found it to be able to use each field of application in the truck cab. Number 1 stood for *not at all important* and number 6 stood for *very important*. The selection of fields of applications included in the questionnaire was based on the background research of truck driver's work tasks. Thus some fields of applications that could be used for their common work tasks were included.

To make sure to get a good mixture of different fields of applications in the questionnaire the web page of Statistics Sweden (Statistiska Centralbyrån, 2011) was used as source to find fields of applications that a majority of people use. The drivers also had the opportunity to write down other fields of applications that was not already listed in the questionnaire.

4.3.2 The interview study

To get participants to the interview study the interviewer stood outside the restaurant at the rest stop, asked people who stopped by if they were truck drivers, and if they wanted to participate in an interview. The interviewer and the interviewee went in to a room next to the restaurant where the interview was held. All drivers who participated in the interview got a food coupon that they could either save for later use, or use directly in case they wished to eat during the interview. The interviews were recorded on a laptop and the answers were also written down by hand. Each interview lasted for about 30 minutes.

The interview material consisted of the same demographic questions as in the questionnaire study. A semi structured interview template with both closed-ended questions and open-ended questions were used. The questions in the interview template were developed to answer the research questions.

4.3.3 Interpretation workshops

Interpretation workshops were held at 3 occasions during the study including 5 to 10 persons working with driver interface at Volvo Trucks. The workshops were held to discuss the data from the questionnaire study and the interview study, and to decide how the work should continue to accord with the interests of the company.

4.4 Method of analysis

This part describes the methods used to analyze the data from the questionnaire study and the interview study.

4.4.1 Questionnaires

The data from the questionnaires were analyzed through the program IBM SPSS Statistics 19, to get descriptive statistics on the importance of the different fields of applications, and to find any correlation between the demographic data and the data on the fields of applications. After the elimination of one questionnaire that wasn't properly filled out, a total of 35 questionnaires were collected.

4.4.2 Interviews

To compile and analyze the interview data two of the five methods of analyses described by Kvale (1997) were used, namely *meaning concentration* and *meaning categorization*. Meaning concentration means that the statements from the interviewees are interpreted and reformulated to get shorter and more concise. This is done to a great extent during the interview itself. Meaning categorization means that the interview is coded in different categories (Kvale, 1997).

The interview material was *concentrated* mainly during the interviews, and analyzed by structuring the concentrated statements in a way which gave an overview and made

comparisons between the statements possible. This was done by sorting the answers in different *categories* based on the questions in the interview template where each interviewee's answer was put. In this way it was possible to compare the drivers' opinions and to write a summary of the interview results.

4.4.3 Function analysis

Based on the questionnaire results a function analysis was conducted to show what functions a future system for the Internet in the truck should have. The classification of *necessary*, *desirable*, and *unnecessary functions* was based on the means of how important the drivers had classified the different fields of applications. A function was classified as necessary if it had a mean over 3.5, as desirable if it had a mean over 2.5, and as unnecessary if it had a mean under 2.5.

4.4.4 Concept design

The basis for the concept design was the goals-means method. The drivers' goals and needs were found through the questionnaires and interviews and were used to develop personas and requirements for the concept (i.e. the means).

The concept design was based on the personas and requirements, and consists of a tree structure of the menus and functions (or applications) of the system, a written description of each application, and the physical design of the system.

5 Results and Analysis

This part starts with a presentation of the results of the questionnaire study, followed by the results of the interview study, the results analyzed and divided into eight personas, the selection of the most interesting personas, the requirements, the concept design, and scenarios of how the system will be used.

5.1 Questionnaire results

Below the 23 fields of applications of the Internet are listed in the order of importance indicated by the participants in the questionnaire study.

Table 1. Fields of applications of the Internet, listed in the order of importance for the drivers.

Field of application	Mean
Finding maps and information about roads and paths (34 answers)	4.8
Finding information on weather and road conditions (35 answers)	4.4
Keep in touch with dispatcher/hauler (34 answers)	4.2
Keep in touch with friends and family at home (35 answers)	4.0
Finding information about traffic queues on the roads (35 answers)	4.0
Finding information about the city you are in (35 answers)	3.8
Finding information about traffic accidents (34 answers)	3.8
Keep in touch with fellow workers/colleagues (35 answers)	3.7
General information search (through a search engine) (35 answers)	3.5
Watch web TV (34 answers)	3.4
Finding technical information about the truck (35 answers)	3.4
Handle order lists (33 answers)	3.4
Finding information about rest stops, restaurants and gas stations (34 answers)	3.4
Using social networks (35 answers)	3.3
Finding information on ferry time tables (34 answers)	3.2
Read online magazines (35 answers)	3.2

Listen to web-radio (34 answers)	2.8
Finding Health Information (35 answers)	2.6
Download software (35 answers)	2.3
Play online games (35 answers)	2.2
Download games, pictures, movies or music (35 answers)	2.1
Reading and/or Write blogs (34 answers)	1.7
Working with your own web site (34 answers)	1.5

5.1.1 Function analysis

Below the 23 fields of applications of the Internet are analyzed through function analysis and classified as *necessary*, *desirable*, and *unnecessary functions*.

Table 2. Fields of applications of the Internet classified by function analysis.

Function	Class
Work related:	
Finding maps and information about roads and paths	Necessary
Finding information on weather and road conditions	Necessary
Keep in touch with dispatcher/hauler	Necessary
Finding information about traffic queues on the roads	Necessary
Finding information about the city you are in	Necessary
Finding information about traffic accidents	Necessary
Keep in touch with fellow workers/colleagues	Necessary
Finding technical information about the truck	Desirable
Finding information about rest stops, restaurants and gas stations	Desirable
Handle order lists	Desirable
Finding information on ferry time tables	Desirable

Private:	
Keep in touch with friends and family at home	Necessary
General information search (through a search engine)	Necessary
Watch web TV	Desirable
Using social networks	Desirable
Read online magazines	Desirable
Listen to web-radio	Desirable
Finding Health Information	Desirable
Download software	Unnecessary
Play online games	Unnecessary
Download games, pictures, movies or music	Unnecessary
Reading and/or Write blogs	Unnecessary
Working with your own web site	Unnecessary

5.2 Interview results

In this part the results of the interviews are summarized within the research question it's most connected to. The results will generally be presented by dividing it on the drivers who already are using the Internet in the truck today, and the ones who are not, since the circumstances differ quite a lot between those two groups of drivers.

5.2.1 What are truck drivers' needs for a web browser in the truck cab?

The needs differ a lot among different truck drivers, although almost all of the drivers either use the Internet in the truck today or would like to do so. 19 of the 30 drivers who participated in the interview already used the Internet in the truck today, and among the 11 who did not 6 would like to use it. The reason why they did not use it today was because they didn't have any device to use it through or just hadn't gotten it yet. Among the ones who did not want to use the Internet in the truck the reason was that they didn't have any interest or any need for using it.

When it comes to things that the drivers consider essential for their work to function properly, the most common answers among the *drivers who use the Internet today are*; that

the communication with the hauler is good, that the driver himself is alert and healthy, that the truck is in good condition, that the weather and the road surface conditions are good, and that the time is well planned. Other important things are that the loading and unloading lists are well planned, and that the other drivers on the roads are behaving as they should.

Things that they wish they could have more influence on are; the driving and rest time rules which they think are to strict today, the salary, and the amount of time for each order. Some of the drivers think their work is fine as it is today and don't have any desire to influence it more, and a couple of them think that the best way to influence the work situation is to be nice to the customers.

Among the *drivers who don't use the Internet today* things that are considered essential for their work to function properly are; that the car is in good condition, that the communication with the hauler works well, that the loading and unloading is well planned, and that the driver is alert and healthy.

Things that they wish they could have more influence on are; the amount of time for each order, and the driving and rest time rules. Some of them feel no need to have more influence on their work situation.

5.2.1.1 *What fields of applications of a web browser do they need?*

The interview data showed that the drivers who already use the Internet in the truck today, mostly on their own laptops, find more fields of applications important than the drivers who were not using the Internet in the truck yet.

The results clearly showed that among the *drivers who already use the Internet today* the most popular fields of applications were Facebook (FB) and map sites where they can search for addresses, companies etc. like hitta.se and eniro.se. They use FB to stay in contact with friends and family at home, and think it is a very good way of killing some time before going to bed at night in the truck. The map sites were important to them since they find it easy to search for addresses and companies online, and to find an appropriate road to get there. It's a faster and simpler way to find the information you need compared to alternatives such as making phone calls, looking at paper maps or pull over to look at the big maps on the signs along the roads. Some of them also commented that the overview is better on the maps online compared to the maps on a GPS, and it's easier to create an overall picture of the route.

Other fields of applications commonly used were driving order programs, online news, random surfing, and online music, movies and audiobooks. To use driving orders online, through e-mail or an order program was popular among the drivers since according to them it made their work simpler and more efficient. It made it possible for them to see all the information related to each order in one place, like the address, contact information etc. and

it reduced a lot of phone calls during driving time. To read news online was important for them to stay updated on what's happening in the world, and also worked as a time killer. Random surfing was used as pure pastime. The same pass for online music, movies and audiobooks, and those fields of applications were also appreciated since there's unlimited access to it online.

The remaining fields of applications that not so many drivers used were e-mail, chat, trucking sites, weather sites, buy and sell sites like blocket.se, and distance advice of delivery.

When asked if there were any fields of applications they didn't use today but would like to use one of them answered that he would like to use a site for truck drivers where one could recommend one another on different good rest stops etc. It would be fun and interesting. Another driver would like to learn how to download music so that he could listen to it while driving. Two of the drivers would like to be able to connect the GPS with the online maps, and the order system. In this way they would like to have all the information connected and to be able to get information from the online maps and the orders transferred into the GPS, and get guidance to those places. One driver would like to be able to find information on road surface conditions, and construction work on the roads. Another driver wanted to be able to take pictures of damaged goods and send to the hauler, one would like to play online games, and one watch movies, if he had a faster Internet connection. One would like to have the driving orders online to be able to have all information collected in one place and get rid of paper orders.

The most wanted field of application among the *drivers who do not use the Internet today* was, in conformity with the drivers using it today, map sites like hitta.se and eniro.se. The drivers wanted to use these sites since they think you can find more information with online maps than through GPS or paper maps. The other two fields of applications that were most wanted were FB and chat programs. They would like to use it to stay in touch with friends and family at home.

The remaining fields of applications that not so many drivers wished to used were e-mail, blocket.se, and to search for rest stops where they could pull over to take a break.

When asked if they were interested in using the Internet on an integrated system in the truck, almost all the drivers who were wanted to get their driving orders into such a system. And several of them wished they could get a connection which made it possible to use the information in the orders directly through the GPS guidance with such a system.

5.2.1.2 *In what situations do they want to use a web browser?*

When it comes to the *drivers who are already using the Internet in the truck today* they use sites for online maps usually by searching for an address just before starting to drive, and

about half of them also use it to throw a quick glance at the map while they are driving. They use the Internet for driving orders mostly when they have stopped at a customer, while loading or unloading. A few of them also use it while they're driving, to look at an order, or to accept a new incoming order. All of the drivers who are using FB, e-mail, and chat programs are all doing it at nights, when they have stopped at a truck stop where they're going to spend the night. The only exception was one driver who said he also uses chat programs on his laptop while driving. The movies, web-TV and audiobooks are all used at nights as a pastime before going to sleep, and the music while driving. Random surfing the web and reading the news online are also mainly done at nights before going to sleep in the truck, except a couple of drivers who use it at breaks during the day when they have pulled over to a rest stop

The remaining fields of applications only used by a few drivers are; distance advice of delivery which is used before starting to drive to a place where a trailer is to be picked up, blocket.se and trucking sites which are used at nights at the end of a working day when parked at a truck stop, and weather information which is used either at nights or while standing still at a customer or having a break.

The *drivers who are not using the Internet today* but would like to use it for getting access to FB would like to do so at nights. The ones who want to use online maps would like to do so during the day, but only when standing still; except for one driver who would want to be able throw a quick glance at the map while driving. The ones who want to use e-mail and chat to contact friends and family would like to do so during breaks at the day time and also at nights before going to bed in the truck. The driver who wants to use blocket.se also wants to do so at nights.

5.2.1.3 *Are the needs different for work-related uses and private?*

A majority of the drivers, both the ones using the Internet today and the ones who wish to use it, want to use the Internet for private use most at nights, as a form of time killer, before going to sleep in the truck. The work related fields of applications need to be used more during the day.

The work related tasks used online by the *drivers who use the Internet today* are; online map sites, online driving orders, weather, and distance advice of delivery. The private fields of applications use by these drivers are; FB, online news, music, movies, audiobooks and web-TV, random surf, e-mail, chat, trucking sites, and blocket.se.

The *drivers who are not using the Internet today*, but who would like to do so, want to use work related applications such as online map sites and online driving orders. The private fields of applications these drivers would like to use are; FB, chat, e-mail, blocket.se, and to search for rest stops along the road.

When asked if they were interested in an integrated system almost all drivers who were said they wanted to get the driving orders into it, even if they hadn't mentioned an interest for online driving orders before the question of the integrated system. Hence a majority of the drivers, when thinking about an integrated system picture using the driving orders in it. None of the drivers mentioned any additional *personal* application of the Internet when asked about the integrated system that they hadn't already brought up before the question of the integrated system.

The work related applications are mentioned to be used (or wished to be used) for making the work more efficient and simpler, and plainly to make the different tasks work. They are also mentioned to be used to get rid of other tasks. The order program lets the drivers get rid of many phone calls and papers. The private applications are used mainly for time pass at nights, and the amount of private applications used are many more compared to the work related applications.

5.2.2 What kind of device is best suited for truck drivers' needs?

Since the needs of different applications differ a lot among the drivers, so do the device which would best suit their needs. Among the 19 drivers who use the Internet in the truck today 14 of them are using a laptop, 3 of them a smart phone, and 2 of them both laptop and smart phone. Most of them bring their own laptop to their trucks and only 3 of them get a laptop from their haulage firm.

23 of all the drivers get a mobile phone from their firm. The 4 drivers who run their own firm use the same mobile phone for work calls and private calls. One of the drivers who was not using the Internet today got an iPhone from his firm, but was not aware he could use the Internet on it.

7 of the drivers had a palm computer that sits in a holder on the dash board, and 1 of them had a board computer with a screen in the dash board. Among the ones who have a palm computer 3 of them use it for handling driving orders, one for driving orders, fuel reports, and driving and rest times, one have both orders and GPS in it, but doesn't use the GPS since he thinks his own GPS works better, and one uses it for GPS and to report driving times. 4 of the drivers think the palm computer works well for the driving orders, and it's nice to get rid of all the paper orders. 3 of them say the palm computer is somewhat clumsy to use, that it doesn't show enough information about the companies' addresses etc, and that it sometimes loses its connection. One says he can use the Internet on the palm computer, but that he doesn't do so since the screen is too small. The driver who has a board computer uses it for GPS and to handle orders. He likes that all the orders are collected in it, and think it works well when the connection is good, but sometimes it loses its connection.

Among the *drivers who already use the Internet in the truck today* 3 mentioned that they would like to use an iPad instead of the laptop they use today, since it would have been

more suitable for their uses. 2 of the drivers mentioned they would like to use it on an integrated system in the truck, since it would be nice to not having to bring the laptop. They also said that it was important that the screen should be bigger than the ones that exist in the trucks today. 1 of the drivers who used the mobile phone today would like to use a laptop instead, since the bigger screen would make it easier to do more different things.

Among the drivers who already use the Internet in the truck today 2 mentioned that they were interested in an integrated system for the Internet in the truck. But when they later got a specific question of whether they would like an integrated system for the Internet in the truck as many as 15 of them said yes, 4 said no.

Among the *drivers who don't already use the Internet*, one of them would like to use it on a laptop, one on the mobile phone, and three on an integrated system in the dash board. But when they later got a question of whether they would like an integrated system for the Internet in the truck 6 of them said they wanted to, 5 of them did not. But when asked if there were any single field of application of the Internet they wanted to use on an integrated system 2 of the 5 who first said no changed their answer to yes.

5.2.2.1 *How should the interaction with the device go about to best suit the driver's needs?*

Most of the drivers who use the Internet in the truck today think it works very well for them, and that it is great to have something to do at nights, and that it's also an efficient tool for the work tasks they use it for. Several of them think that the connection could be better though, and they would also like a faster connection. Two of the drivers who use the Internet for their driving orders say that the orders don't always arrive because of bad connection, and that they wished the connection was faster.

A couple of other drivers are very happy with the possibility to use the Internet for the driving orders, it works smooth and they get rid of many phone calls and don't have to write down the order information they used to get by phone calls.

One of the drivers using the Internet on a mobile phone thinks it works well for looking at maps, but when surfing the screen is a little bit too small. Another driver says he would use the Internet more if he had a laptop since the screen on the mobile phone is too small.

The driver who uses the Internet for distance advice of delivery think it works great since it saves a lot of time when you get to the customer. To get weather information online is also appreciated since you can get it whenever you'd like to, and not just when the weather information is sent on the radio.

When asked if they would like to use the Internet on an integrated system in the truck 15 of the ones who *already use the Internet in the truck today*, and 6 of the ones who *do not use*

the Internet today claimed that they would, plus 2 who would like to use it for a single field of application among the ones who do *not use the Internet today*.

Among the 15 *drivers who use the Internet today*, and would like to use it on an integrated system, 1) some of them wanted to use the integrated system mainly for music, movies, and for collecting driving orders and other work related information at one place. They wanted to have a big screen which was visible from different places in the truck. 2) Some others wanted to use it mainly for looking at online maps and to keep contact with friends, and also for handling driving orders. They think it would be good with an integrated system since everything would be collected at one place, and they wouldn't have to bring the laptop to the truck. They would like the system to have a big screen in the dash board that could be turned in different directions. 3) Yet some others of these 15 drivers would like to use an integrated system for looking at online maps, read the news and for all work related tasks and information. To have everything collected at one place would make the work simpler and more effective. They would like to have a screen in the dash board and interact with it through touch screen and a wireless keyboard.

The 3 drivers who *don't use the Internet today*, but who would like to use it on an integrated system, wanted to use it mainly for looking at online maps, handling orders, and to keep in touch with friends and family through e-mail and chat. They would like a swivel screen in the dash board, and to use a keyboard when chatting and writing e-mails. For checking something quick on the maps while driving they think a touch screen would be suitable. A couple of them also wanted the system to be voice controlled.

The two drivers who said they didn't want to use the Internet on an integrated system, except for one single field of application wanted to use it for online maps, and driving orders each.

Most of the drivers have quite strong opinions that a truck driver shouldn't do other things while driving than just driving. Among the *drivers that use the Internet in the truck today* talking on the mobile phone, talking on the mobile phone with hands free, write a text message, listen to music and change settings on the music player are tasks that are considered to be possible to perform while driving. A few of them sometimes also read an address, or check a new order on the computer, or palm computer while driving, and only one of them sometimes uses the chat program at the computer while driving.

When it comes to things that can make the drivers distracted the most common things are elements of surprise, like animals or something unexpected at the side of the road, if the mobile phone rings when the traffic is heavy, and other drivers who show no respect in the traffic. On the other hand several of them also point out that they seldom get distracted, they stay calm and don't get stressed up.

Among the drivers who *don't use the Internet in the truck today* talking on the mobile phone, talking on the mobile phone with hands free, listen to the radio and change settings on it are tasks that are considered to be possible to perform while driving.

When it comes to things that can make them distracted the most common things mentioned are other drivers who show no respect in the traffic, talking on the phone when the traffic is heavy and elements of surprise. But several of them also point out that they don't get distracted easy, since they keep calm and focus on the driving task.

5.2.2.2 *Where should the information be presented?*

Almost all the *drivers who use the Internet today* use it on a laptop. How and where in the truck they use it varies a lot.

One driver uses it in his lap while sitting in the driver's seat, or keeps it on a small bench he's built and placed on the passenger's seat. Another driver turns the driver's seat around, raise the bed and use it like a desk. Two of the drivers use it sitting on the passenger's seat with the laptop placed on the dash board, and two of them say the location in the truck where they use it varies a lot.

When using the laptop for looking at online maps most drivers sit in the driver's seat and put the laptop either on top of the dash board or on a bench on the passenger's seat, and put it away when start driving. A couple of them keep the laptop on the passenger's seat or to the side of them while driving so that they can throw a fast glance at the map while driving.

When it comes to the use of online driving orders a couple of drivers keep the laptop on a bench beside the driver's seat so that they can see when a new order arrives, and another use it while sitting in the driver's seat, and then puts the laptop away while driving.

The drivers who use the Internet for listening to music and audiobooks while driving keep the laptop to the side of the driver's seat but don't use it to anything but listening to it while driving.

When it comes to all the other private uses of the Internet, like watching movies, reading the news, using FB, random surfing, and chatting, it varies a lot where the driver choose to sit and use the laptop in the truck. Many of the drivers bring the laptop back to the bed and keep it in their lap or put it down on the bed, some of them sit in the driver's seat, some in the passenger's seat, and many of them often vary the location.

Among the *drivers who are not already using the Internet in the truck*, but who would like to use it, the preferences on where to use it also varies a lot. Some of them want to sit in the driver's seat, some in the passenger's seat, some want to be able to use it at different places in the truck, and 3 mentioned that they would like to use it on an integrated screen in the

dash board. One of them wants it to be used just like a laptop only built in; with a screen and a keyboard. The other two had no specific wishes on how it should be used.

When asked if they would like to use the Internet on an integrated system in the truck 23 of them would, including 2 who only wanted to use it for a single field of application.

All of the drivers who would want to use an integrated system for the Internet want to see the information on a screen in the dash board. The ones who want to use the Internet for many different fields of applications, both personal and work related, mostly want a quite large screen, and they also want to be able to turn the screen in different directions, so that they can use it from different places in the truck. The drivers who only want to use the Internet for a few different applications don't have as high demands on a big screen that has to be able to turn.

5.3 Personas

From the interview data presented above 8 different personas were developed to represent different kinds of drivers when it comes to Internet usage and needs for the Internet in the truck. Some different behavioral variables (Goodwin, 2009) were identified, from which the interviewees were mapped, and personas developed. The behavioral variables were based on *the Internet usage* among the drivers today, their *attitudes towards an integrated system* for Internet usage in the truck, and what different *fields of applications* of the Internet they were interested in. The tree structure below shows the different behavioral variables and the personas that were developed from them. After the tree structure each persona is presented in more detail.

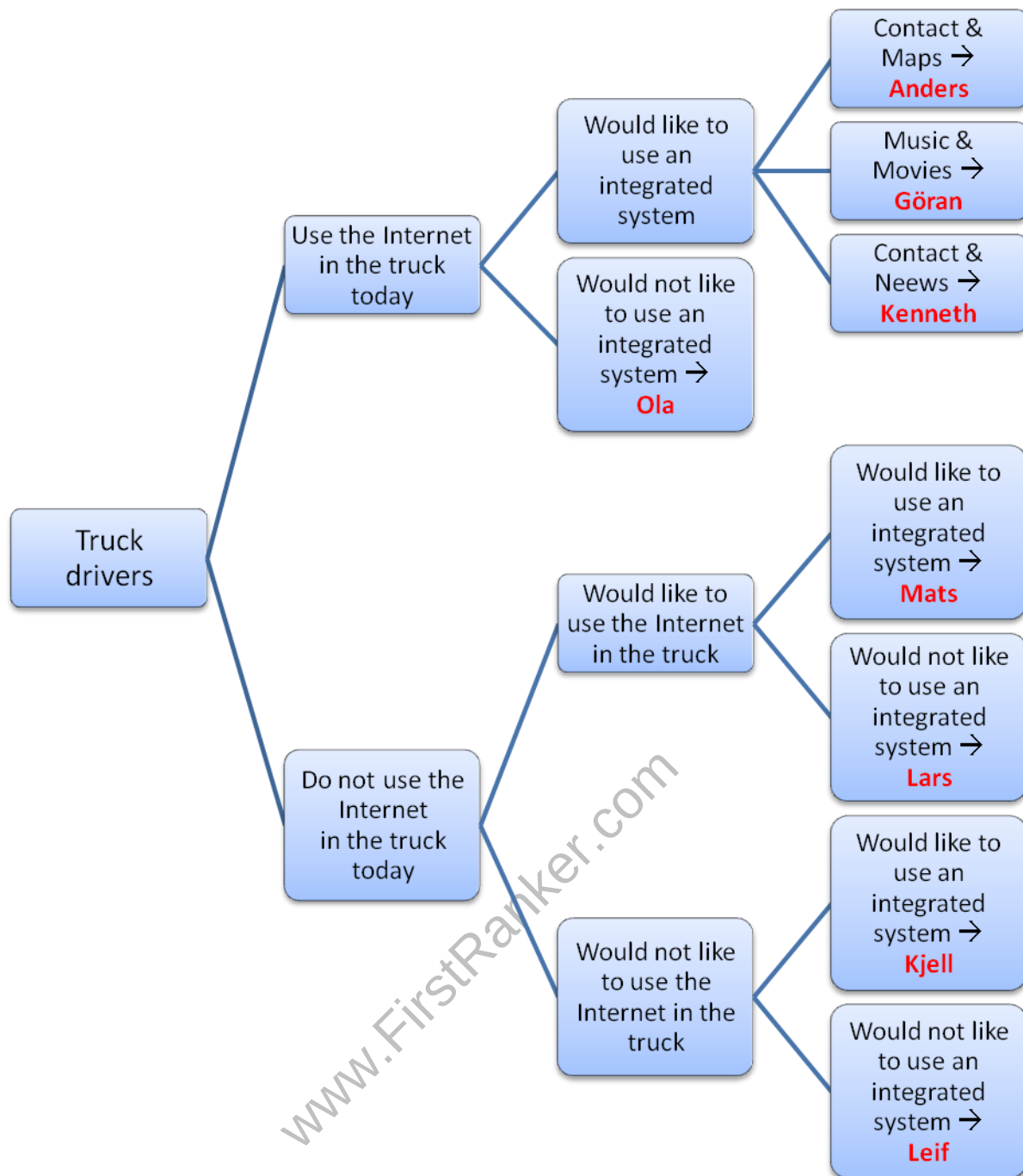


Figure 1. Tree structure showing the behavioral variables used to divide the interview data into 8 different personas.

5.3.1 Anders Hansson

Anders is 33 years old and has been working as a truck driver for 10 years. The last 9 years he has been a long haul driver, and works for a hauler. The firm is providing a mobile phone for his work. Anders sleeps in his truck 4 nights per week. He is single and lives alone. At his spare time he uses the Internet for about 5 hours per week.

When Anders is away for work he brings his laptop into the truck to be able to use the Internet for online maps, and different ways of keeping contact with friends.

He thinks using the Internet is a good way of finding addresses to customers if the address is missing in the driving order, and to look at online maps to find the best way to get there. The applications he most often uses is eniro.se and hitta.se. He thinks the overview is better and clearer when looking at maps online compared to the ones in the GPS or on paper maps. Anders usually search for the address and maps online when he's standing still, and throws a glance at it while he's driving. He keeps the laptop on a tabletop diagonally in front of him.

At nights Anders uses e-mail, chat and FB to keep contact with friends and family. Doing this is also a good way of killing some time before going to sleep in the truck. He thinks it is fun to get updated on what happens in friends' and family's life while he is away working. When using these social networks it varies where in the truck he is sitting, but usually he brings the laptop back to the bed.

Anders thinks using the Internet on his laptop works quite well, but sometimes it loses its connection and sometimes it's slow. He would like to use the Internet on an integrated system in the truck if the screen was as big as the screen on his laptop. It would be nice not having to bring the laptop from home. He thinks the screen should be placed in the dashboard and it would be good if it was possible to turn it in different directions so that he could sit at different places in the truck cab. It would be handy to have everything collected in one system. Anders would like to use it both for the things he's using at the laptop today, and for driving orders to get rid of papers and telephone calls.

Anders thinks talking on the phone, throw a glance at an order on the laptop, and writing a text message is okay to be doing while driving. But one should not do more complicated things on the laptop or stretching for something on the floor since it would steal too much attention from the road. Sometimes he can get distracted from the driving task while writing a text message, and he sees that as a sign for stop doing that while driving. Other things that can be distracting is other cars on the road which are driving strange, lacking respect and are negligent in the traffic.

Goals:

- Use the Internet to find addresses and maps.

- Use the Internet to stay in touch with friends.
- Have all uses of the Internet collected in one system, including order information.
- Use the Internet on an integrated system with a large screen that can be turned in different directions.

5.3.2 Göran Lundin

Göran is 47 years old and have been working as a truck driver for 15 years. He has been a long haul driver since he started to drive trucks. He works for a hauler, and sleeps in his truck 5 nights per week. The hauler is providing a mobile phone for Göran's work calls. When Göran is at home, at the spare time, he is using the Internet for about 30 hours per week.

Göran has both a laptop and a smart phone on which he can use the Internet in his truck, but most of the time he uses the laptop since it's got a bigger screen. He uses the Internet to a bit of everything, but his main uses and interests are music and movies. He likes to listen to music while driving and thinks it's perfect to not having to bring CDs in the truck, and use the Internet to find music instead. At nights Göran really enjoys being able to look at movies and online TV on his laptop before going to sleep. He also surfs around the web a little at nights. Sometimes he also looks up some address or look at an online map.

During the day Göran places the laptop somewhere where he can see it from the driver's seat in case he needs to have a brief look at the map or change the music. At nights, when watching movies or surfing, he varies places to sit in the truck.

Using the laptop for the Internet works well for Göran, but if there was access to an integrated system for the Internet in the truck he would like to use it. The screen had to be big enough to watch movies on, and visible from different places in the truck. He would also use it for surfing and looking at maps, and would like the driving orders and all the work related information to be in it to. In that way he wouldn't need to get papers and phone calls or text messages with order information.

Göran thinks you can use the phone, and write and read text messages while driving. Looking a little bit at the laptop could work if there's not much traffic and you're driving on the freeway. But you shouldn't do more complicated things on the laptop, since the focus still has to be directed to the road. You should definitely not watch movies while driving, like some drivers do. Things that could be distracting are anything that moves the attention away from the road, or other drivers who doesn't know what they're doing.

Goals:

- Use the Internet to listen to music all day while driving.

- Use the Internet at nights to watch movies and surf the web.
- Use the Internet on an integrated system with a large screen that can be seen from different places in the truck.
- Getting work related information, like driving orders, in an integrated system instead of via mobile phone and papers.

5.3.3 Kenneth Gunnarsson

Kenneth is 38 years old, has been working as a truck driver for 16 years, and has been a long haul driver for all of the 16 years. He works for a hauler, and he sleeps in the truck 4 nights each week. He gets a mobile phone from the firm he works at. At home he lives with his family, and at his spare time he uses the Internet for about 5 hours per week.

Kenneth brings his own laptop to the truck when leaving home. His main uses of the Internet in the truck is reading the news online and keeping contact with family and friends. Sometimes he also uses the Internet for random surfing on the web.

Both reading the news and keeping contact with friends and family works as a great time killer at nights before going to sleep in the truck. Kenneth also reads the news because he finds it important to be updated on what's going on in the world, and he also likes to know what friends and family are doing.

Using the Internet on the laptop works fine for Kenneth, but he thinks it would be even better if it could go a little faster. He usually varies the places to sit in the truck when using the Internet, but normally he puts the laptop on top of the dashboard or brings it back to the bed.

Kenneth thinks an integrated system for the Internet in the truck would be a good thing, since then he wouldn't have to bring his laptop all the time. Fewer loose things in the truck are better and safer. He thinks it would be good to have everything in one system, and would therefore like to use it both for the things he uses on the laptop today, and also for work related tasks. It should be a screen in the dashboard that's controlled by touch and maybe also by a wireless keyboard.

Talking on the phone and using the radio can be done while driving, but everything else should be avoided according to Kenneth. One should for example not use the Internet while driving. Kenneth does very seldom get distracted, since he always focus on the driving task, but sometimes even a phone call can be a bit distracting in case the traffic is heavy, or when driving in a city.

Goals:

- Use the Internet to stay updated about what's going on in the world, and what's going on at home among friends and family.
- Use an integrated system instead of the laptop for news and contact with family and friends at nights.
- Use an integrated system for the Internet to work related tasks also during day time.

5.3.4 Ola Henningsson

Ola is 37 years old and has been working as a truck driver for 12 years. He has been a long haul driver for 9 years, and drives for a hauler. The firm contains of 12 trucks, and Ola gets a mobile phone from the firm. He spends 4 nights per week in his truck. At home he lives together with his girlfriend, and at his spare time he uses the Internet for about 3 hours per week.

Since Ola spends a lot of time in his truck and sleeps in it several nights per week he finds it great to be able to bring his laptop on the roads. He uses the Internet for a little of everything, and likes to use it as a time killer at nights before going to sleep in the truck, and sometimes also during shorter breaks. He normally just surfs around the web, or uses social networks like FB to stay in touch with his friends.

He also has a program for driving orders on his laptop which works through the Internet, and gives him new orders along the road, and information about the goods and where to load and unload. Ola thinks this program works very well and wouldn't want to change anything about it. When Ola stops at a customer to load or unload goods he verifies this through the program and then he also looks to see if there is any new orders. New orders can also come in while Ola is driving, and then he usually glances at the computer screen to see what it is and accepts the order.

During his workdays he keeps the laptop on a tabletop diagonally in front of him, near the passenger seat. When using it at night he usually takes the laptop with him to the bed.

Ola is very satisfied with the way he's using the Internet today, and doesn't have any desire for an integrated system for the Internet in the truck cab. He doesn't feel any need for it, and he finds it flexible to be able to move around the laptop, and thinks that the laptop can be used to more different things than an integrated system could.

Ola says there's not many things that get him distracted while driving, he usually stays calm. Sometimes he might feel distracted if there's an element of surprise that steals the focus away from the road. He thinks one can talk on the phone while driving, listen to the radio and take a brief look at new orders, but should stay away from more complicated tasks.

Goals:

- Use the Internet quick and easy for work related tasks during the day.
- Use the Internet for many different things as a time killer before going to sleep in the cab.
- Use the Internet from different places inside the cab.

5.3.5 Mats Åberg

Mats is 45 years old and has been working as a truck driver for 22 years. During 20 of those years he's been a long haul driver. He drives for a hauler, which provides him with a mobile phone for his work. He stays away from home and sleeps in his truck 4 nights per week. At home he lives with his family, and at his spare time he uses the Internet for about 6 hours each week.

Mats is not using the Internet in the truck today since he's not having a laptop. But he wishes to use it to look at online maps like eniro.se and hitta.se, and to keep contact with family and friends. Mats thinks that maps online shows more and better information than the maps on the GPS, the overview is better, you can find more roads, and find roads suited for trucks. It would be easier with a bigger screen than the screen on the GPS.

Mats would like to use the Internet to contact friends and family as a time killer at nights, and search for locations at online maps before starting to drive, and throw a glance at them while driving.

He wants the information to be displayed on a screen in the dashboard which could be turned in different directions. During the day he wants to be able to see it from the driver's seat, and at nights he wants to turn it towards the passenger's seat or the bed. He wants to be able to use a keyboard for typing, but it could work with a touch screen in case he needs to check something quick while driving.

Mats thinks you shouldn't do anything but talking on the phone while driving. That means the commands for using an integrated system must be very simple in case a touch screen should be used for maps etc. Things that can distract Mats while driving are things that move the attention away from the road.

Goals:

- Use the Internet to look at maps and keep contact with family and friends.
- Use an integrated system through touch screen and keyboard.
- Stay focused on the driving task.

5.3.6 Lars Andersson

Lars is 61 years old and has been working as a truck driver for 40 years and as a long haul driver for 20 years. He drives for a hauler and sleeps in the truck about 3 nights per week. The firm provides him with a mobile phone for his work. He has a family, and he lives together with his wife. At his spare time he uses the Internet about 2 hours per week.

Lars is not using the Internet in his truck today; he doesn't feel any greater need for it. He would like to use it sometimes though, but he hasn't gotten a laptop yet, which is the reason why he's not using it today. If he had had a laptop he would have used the Internet for personal use only, like using FB, and keep in touch with friends. He would have used it as a time killer at nights and would want to use it at different places in the truck.

He thinks that new technology is always a good thing, but he has no personal interest of an integrated system for using the Internet in the truck, and has no need for it. He would rather use a laptop for personal use of the Internet. Still if there was an integrated system in the truck he might use it a little for work tasks, like looking at maps and search for addresses, but he doesn't have any desire for it today.

Lars thinks it's okay to talk on the phone without using hands free while driving, but it's important to stay away from doing other things. Sometimes when something unexpected happens it can distract Lars when he's driving. Beautiful girls near the roads can also be somewhat distracting according to Lars.

Goals:

- Keep focus on work during the day.
- Get a laptop to use the Internet for personal use at nights.
- Use the Internet to keep contact with family and friends.

5.3.7 Kjell Bengtsson

Kjell is 59 years old and has been a truck driver for 24 years. Right now he is a long haul driver, and has been for 14 years. He drives for a hauler, who is providing a mobile phone for his work. He spends 4 days away from home per week and sleeps in the truck. At home he uses the Internet for about 1.5 hour per week at his spare time, he's got a family and he lives with his wife.

Kjell does not use the Internet in the truck today, neither for personal use or any work related tasks. He wouldn't want to do so either, since he doesn't feel that he has any use for it. He would like to use it if there was an integrated system though. It would be nice to have the work related information online in such a system. But he would still have no private use for it. He would like to use it for driving orders, GPS-function and looking at online maps. The

maps online are better than the ones in the GPS, the overview of the roads are more clear. He thinks the communication with the office would be more effective if he could accept and confirm the orders right away through the Internet. It would be nice to have all the orders and the information collected in one place, not having them spread in different text messages and on papers. In that way he wouldn't have to make as many phone calls either, and not having to spell the addresses heard through the phone and write them down, which would decrease mistakes.

Kjell would like the information to be displayed on a screen in the dashboard and it should be easy to read it. Maybe the information could be read out as a voice too, and the orders could be accepted through a voice command to avoid moving the focus away from the road. More advanced commands could be done through a touch screen when not driving. All the commands should be simple and effective.

The only thing you can do while driving is talking on the phone using hands free according to Kjell. Everything else steals too much of your attention from the road. You shouldn't even be smoking or reaching for the snuff-box. Since Kjell keeps his attention to the driving task he states he seldom gets distracted or stressed. It could be slightly distracting sometimes when the traffic is heavy or when there's construction works on the road.

Goals:

- Stay focused on the driving task.
- Use an integrated system for work related tasks.
- Use voice-commands while driving and touch screen when standing still.

5.3.8 Leif Axelsson

Leif is 60 years old, has been a truck driver for 33 years, and has driving long haul all the time. He sleeps in his truck 4 nights every week. He's got a family, and at home he is living with his wife. He uses the Internet for about 3 hours per week on his spare time.

Leif doesn't use the Internet in his truck today, and he would not like to do so either. He just doesn't feel that he has any need for it, and he is not interested in using it.

He is not interested in an integrated system for the Internet in the truck either. If there was an integrated system the only thing he would use it for would be to search for addresses or looking at maps, or handling driving orders to minimize paper orders. It would be simpler to keep track of the orders, and faster and easier to send confirmations to the office.

Leif thinks the most important thing in his work is to have focus on the road and not doing anything but maybe talking on the phone and listening to the radio while driving. Things that

can be distracting when driving are other road users who drive disrespectful, makes insane passing, wobble over the road, or drives close behind.

Goals:

- Stay focused on the driving task.
- Not doing anything but talking on the phone or listening to the radio while driving.
- Use an integrated system only for work related tasks.

5.4 Selection of personas

When the personas where developed an interpretation workshop was held, with people working with driver interface at Volvo Trucks. The personas of most interest for the company where the ones in the bottom part in the personas tree structure, the ones who do not use the Internet today. These personas have a greater need to fulfill. The ones in the top part of the tree, who already use the Internet on a laptop in the truck today, have more specific requirement on an integrated system. And needs that look very similar to needs of using a laptop. Some of them are satisfied with using the laptop as they do today and others wants to use an integrated system in the truck, but they want it to function just like a laptop. The suspicions are that these drivers would have very high demands on an integrated system; it would need to be both better and cheaper than a laptop for them to buy it. Their needs are already fulfilled by the laptop.

The personas in the bottom part of the tree structure, the ones who do not use the Internet today do not have the same needs. These drivers have needs that can be fulfilled by an integrated system since they do not use the Internet today. They have more narrow needs which make it possible to fulfill them in a better way. Many of them are only interested in using the Internet for work related tasks which also makes it more interesting for the haulers to buy a possible integrated system.

The personas in the bottom part of the tree structure were given more focus, and a basis for a possible concept for each of them is presented below, based on the goals, needs and requirements in the personas.

5.4.1 A concept basis for Mats

Mats doesn't use the Internet in the truck today, but he would like to do so, and would also like to use it on an integrated system in the truck.

Mats thinks it's better to look at maps on the Internet on a laptop than on a normal GPS since the screen is bigger and he gets a better overview, and he can find more roads suited for trucks. So the screen for a possible integrated system needs to be rather big. He also

wants to use the Internet to keep in touch with friends and family through chat and e-mail. Since he wants to write a lot a keyboard would probably best suit his needs.

Before starting to drive he wants to be able to search for addresses and program a route to follow, but also be able to look at the map and the route while driving. A touch screen would suit the quick tasks he might have to perform while driving, e.g. zooming in and out on the map, change the screen light etc. When programming the route before driving he should be able to use either a touch screen or a keyboard.

Today Mats would only talk on the phone while driving. Since it's important for Mats to stay focused on the driving task the maps and route information that he needs to see while driving has to be clear and not steal too much focus from the road. The screen should be a swivel screen since Mats wants to be able to use it for maps during the day in the driver's seat and for chat and e-mail during the night at other places in the truck.

Requirements:

Functional requirements:

- Look at maps online, like eniro.se, and hitta.se
- Look at larger maps than on the GPS
- Search for addresses
- Keep in touch with friends and family
- Use e-mail
- Use chat
- Look at maps with roads suitable for trucks, with e.g. height of bridges
- Use GPS-function with roads suitable for trucks, e.g. height of bridges

Quality requirements:

- Write large amounts of text
- Make quick and easy maneuvers while driving
- Easily make quick settings on map/GPS while driving

Data requirements:

- Get a good overview of the maps

- Easily see and understand the information
- Easily look at maps and route while driving

Contextual requirements:

- Stay focused on the driving task
- Use it both at days and nights
- Use it from different locations in the truck

5.4.2 A concept basis for Kjell

Kjell doesn't use the Internet in the truck today, and doesn't really have a desire for doing so either. But if there was an integrated system for the Internet in the truck he would like to use it for work related tasks, like handling orders and looking at maps.

Kjell thinks it would be nice to have all the work related information collected at one place, and it would make the work more effective if he could communicate fast with the office through the Internet. He wants the screen to be placed in the dash board and visible from the driver's seat. Kjell thinks the only thing you should do while driving is to talk on the phone with hands free, so the information should be clear and the interaction should be simple with few commands. Kjell wants to be able to use voice commands while driving. When standing still he wants to use touch screen for somewhat more advanced commands. The order program has to be fast, simple and effective.

Kjell wants to get the information about new orders through both sound and vision, since it would give him greater possibilities to keep the eyes on the road. The system should both have a good screen and good speakers so that the information is heard through the sound of the engine.

Requirements:

Functional requirements:

- Use only work related applications
- Handle driving orders
- Look at maps online, like eniro.se, and hitta.se
- Use GPS-function
- Have fast and effective communication about orders with the office
- Accept and confirm the orders right away

Quality requirements:

- Easily hear information from the system
- Use simple commands
- Use only a few commands
- Accept orders by voice while driving
- Get information through sound and vision while driving

Data requirements:

- Have all work information collected at one place
- Easily see and understand information
- Easily find routes on the map

Contextual requirements:

- Easily see information from the driver's seat
- Keep the eyes on the road

5.4.3 A concept basis for Lars

Lars doesn't use the Internet in the truck today, but he would like to, although not on an integrated system in the truck.

Lars would like to use the Internet a little in the truck, but he doesn't have a laptop so he doesn't use it today. If he had had a laptop he would like to use the Internet only for personal use, like keeping in touch with friends through FB at nights before going to sleep in the truck.

He likes the thought of being able to move around the laptop and use it anywhere in the truck, so he is not interested in using the Internet on an integrated system in the truck. He also wouldn't want to use personal applications on an integrated system.

If there was an integrated system for the Internet in the truck he maybe would want to use it for work related tasks and using online maps, but would rather use a laptop for his personal use. He doesn't have any desire to use anything else today.

Requirements:

Functional requirements:

- Keep contact with friends through FB
- Use only personal applications

Quality requirements:

- Have a personal system
- Write large amounts of text

Contextual requirements:

- Move it around, use it anywhere in the truck
- Usable at nights
- Put it away during working day

5.4.4 Leif

Leif doesn't use the Internet in the truck today, and doesn't want to do that either, not even if there was an integrated system for the Internet in the truck. Therefore no concept was developed for Leif. His goals and needs are already fulfilled with the device he's using today.

5.4.5 A concept basis for Mats and Kjell

Lars doesn't want to use an integrated system for personal use, but if there was an integrated system he might use it for work related tasks. A solution that might suite Lars would be to use an on-board computer, for example Dynafleet, for his work tasks, and to have a personal laptop for using FB etc.

Since Mats and Kjell are the ones who would like to use an integrated system for the Internet in the truck, their requirements lists where syndicated into one, and used as a basis for developing a concept that could satisfy their needs. Some of their needs where the same and had similar requirements, and some of them could be combined.

In a system for using the Internet in the truck the best solution seems to be to make it possible for the driver to have a personal profile, containing only the applications he is interested in. Kjell only wants to use work related functions so he should be able to choose only those applications for instance.

Requirements:

Functional requirements:

- Look at maps online, like eniro.se, and hitta.se

- Look at larger maps than on the GPS
- Search for addresses
- Keep in touch with friends and family
- Use e-mail
- Use chat
- Look at maps with roads suitable for trucks, with e.g. height of bridges
- Use GPS-function with roads suitable for trucks, e.g. height of bridges
- Use only work related applications
- Handle driving orders
- Have fast and effective communication about orders with the office
- Accept and confirm the orders right away

Quality requirements:

- Write large amounts of text
- Make quick and easy maneuvers while driving
- Easily make quick settings on map/GPS while driving
- Easily hear information from the system
- Use simple commands
- Use only few commands
- Accept orders by voice while driving
- Get information through sound and vision while driving

Data requirements:

- Easily see and understand the information
- Get a good overview of the maps
- Easily look at maps and route while driving
- Easily find routes on the map

- Have all work information collected at one place

Contextual requirements:

- Stay focused on the driving task
- Use it both at days and nights
- Use it from different locations in the truck
- Easily see information from the driver's seat

5.5 Goals-means analysis into Concept

From the questionnaire study and the interview study truck drivers' goals and needs for using the Internet in the truck were explored. Based on these goals and needs, requirements were developed and used as a ground for developing the means needed to reach the defined goals.

The means are presented below as a concept for a system for using the Internet in the truck, in the shape of a hierarchical tree structure of the system menu and applications. Each part in the system is described below the tree.

The development of the menu tree was based on the needs and tasks, rather than on the underlying processes of the system (Norman, 2008), which also accord with the JCS approach. The different applications that the drivers needed were outlined and clustered together in different groups of applications that are similar or will be frequently used together. By clustering items in a menu in this way it can facilitate the interpretability of the items and reduce the time of selection among items (Norman, 2008). The clustering was made in both a top-down and bottom-up manner since both brings important aspects to the menu structure (Norman, 2008). The choice of words for the different items in the menu is important since the word gives information on what the item consist of. It's also important to choose words that are distinctive from one another to ease the selection between items in the menu (Norman, 2008).

The system for using the Internet in the truck should be able to be adapted for different drivers, by letting them decide what applications they want to have access to. The drivers should be able to choose from both the different applications belonging to the system, like the order program, and from different other general and common applications, like for instance FB or Messenger. A driver who is only interested in using the application for driving orders should only need to have that application installed in the system in his truck. Whereas a driver who wants to use the GPS, the order system and the chat program to contact his family should be able to get those applications etc.

There should be a security lock function in the system, which makes it impossible to use some of the applications in the system while driving. The reason for this is that the system should not lower the safety by stealing the driver's attention from the driving task. A good starting point in the design process could be to keep all the personal applications locked while driving.

Below the system menu adapted for the primary personas' (Mats and Kjell) desires, including the applications they need is presented.

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5.5.1 Menu structure

The system menu adapted for Mats and Kjell is presented below.

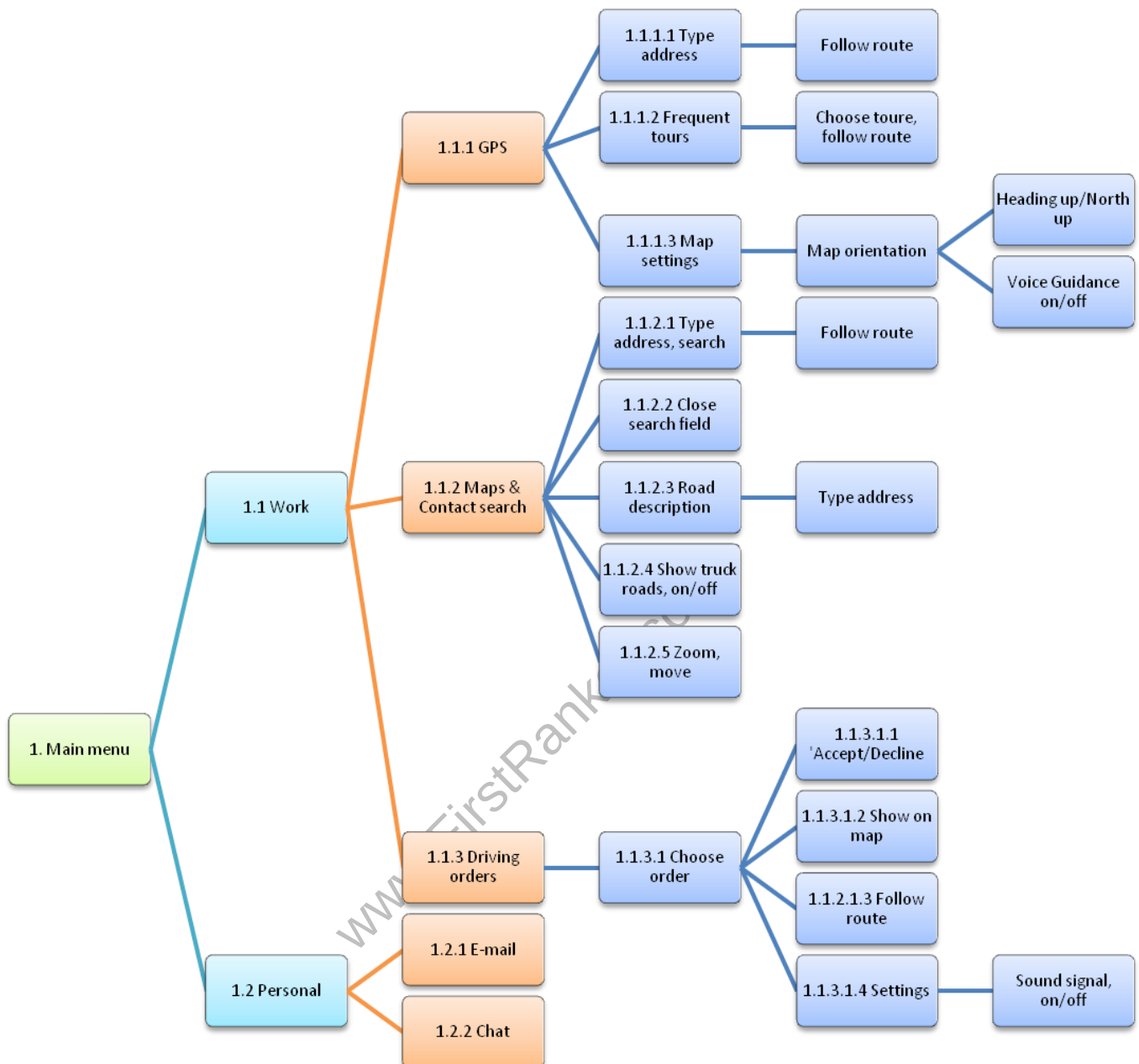


Figure 2. Tree structure of how the different applications are clustered to form the system menu.

The clustering of applications resulted in a hierarchical tree structure. The first two clusters are *Work* and *Personal*. That decomposition was very natural based on the results from the interviews showing that the needs differ quite a lot between work applications and personal applications.

1. Main menu

1.1. Work

From the *Work* item in the menu the driver finds all the work related applications he has chosen to use, *GPS*, *Maps & Contact search*, and *Driving orders*.

1.1.1. GPS

When choosing the *GPS* item, the driver reaches the applications he needs to get guidance to a desired location.

1.1.1.1. Type address

This is the step where the driver *types the address* of the location he's going to, in the address fields, either by using a wireless keyboard with touchpad, or by using the touch screen. When searching for a location the driver can choose to only show roads adapted for trucks when getting the route to follow. This means the GPS will never lead the driver to a road with a low bridge, etc.

1.1.1.2. Frequent tours

When choosing *Frequent tours* the driver gets a list of his most visited places and can choose the place he wants to go to, without typing the address.

1.1.1.3. Map settings

In the *Map settings* item the driver can make different settings for the GPS functions, like choosing the direction of the map, heading up or north up, and turning the voice guidance on or off.

1.1.2. Maps & Contact search

When choosing the *Maps & Contact search* item the driver can search for locations on online maps, and search for companies' contact information etc.

1.1.2.1. Type address

The start page of the *Maps & Contact search* is showing a map, and a search field on the right, where the driver can type an address, a phone number, or a company name etc. to search for. When the location is displayed on the map the driver can choose to press an icon called *Follow route*, which means that the map location is transferred to the GPS function which starts the guidance.

1.1.2.2. Close search field

When the map is showing the location the driver searched for, the driver can choose to close the search field, to get a larger picture of the map, covering the entire screen.

1.1.2.3. Road description

The driver can also choose to type the name of a company etc. and choose to show the road description on the map and as text. If that information wasn't enough he can choose to press the button *Follow route* to get guidance through the GPS

1.1.2.4. Show truck roads, on/off

At the top of the map there is an icon for turning the *Show truck roads* on or off. When activated the map or road description shows only roads suited for trucks, i.e. not showing any roads with low bridges etc.

1.1.2.5. Zoom, Move

Trough the touch screen or the touch pad on the keyboard the driver can zoom in an out on the map, and move the field of view in different directions.

1.1.3. Driving orders

In the *Driving orders* application the driver finds all the information about his orders.

1.1.3.1. Choose order

The first screen shows a list of all the orders that the driver got from the hauler. At the top the accepted driving orders are listed in order of execution time, and in the next section orders that haven't been accepted by the driver yet are shown. When pressing an order in the list all information about the order is shown, e.g. the type of goods, where to load and unload, at what times, and contact information to the company etc.

1.1.3.1.1. Accept/ decline

When showing all information on an order, the driver can choose if he has time to carry out the order and either accept the order or decline it. This information is sent directly to the hauler office.

1.1.3.1.2. Show on map

When showing the order information there is also an icon called *Show on map*, which takes the address information from the order and starts the map application to show the driver the company's location on the map. This can also be used when for example some information on the order is missing, since when searching for the location on the map the driver also gets all the information on the company, just like when searching in the map application.

1.1.3.1.3. Follow route

When showing the order information there is also an icon called *Follow route*, just as in the map application, which gets the address information from the order and starts the guidance through the GPS.

1.1.3.1.4. Settings

In the *Settings* the driver can decide whether to get a sound signal when a new order is coming in or not, etc.

1.2. Personal

Under the item *Personal* the driver collects all the personal application he wants to have access to. He can also program a password for this section if wanted. He can install whichever programs he would like to use, maybe the ones he's familiar with from using at home.

1.2.1. E-mail

When entering the e-mail application the driver opens up the e-mail program he has chosen to install, for example the G-mail.

1.2.2. Chat

When entering the chat application the driver opens up the chat program he has chosen to install, for example the MSN-messenger.

5.5.2 Physical design

During the interviews the drivers had some opinions on what the physical design should be like. Based on these opinions, and based on the requirements lists, the following physical design properties for the system have been sketched.

Hard ware:

- Big screen (about 11 inches)
- Swivel screen on extension arm
- Touch screen
- Wireless keyboard with touch pad, and good connection to the system
- Good speakers
- Good microphone

Physical buttons:

- Button on steering wheel to activate microphone
- Button to turn the screen off while system going, or to turn the system off
- Button to change the strength of the screen light
- Button to turn the signal for new orders on or off
- Button to turn the voice guidance on or off

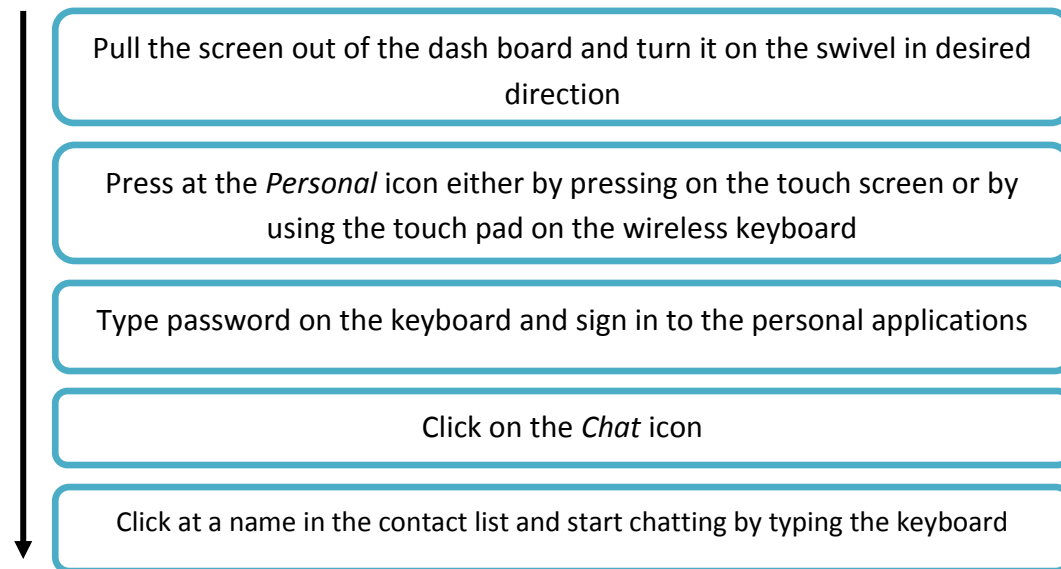
5.6 Task flow

In this part task flows are presented to show the steps in using the applications that Mats and Kjell need in their system.

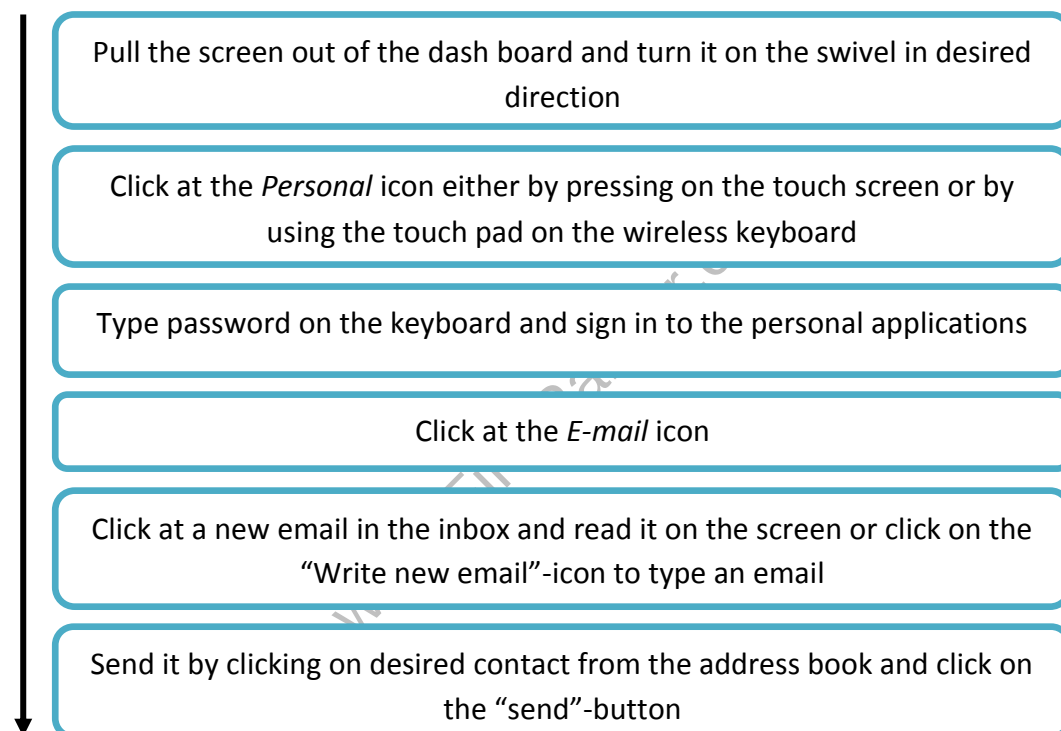
5.6.1 Mats

Task flows for the different applications that Mats needs.

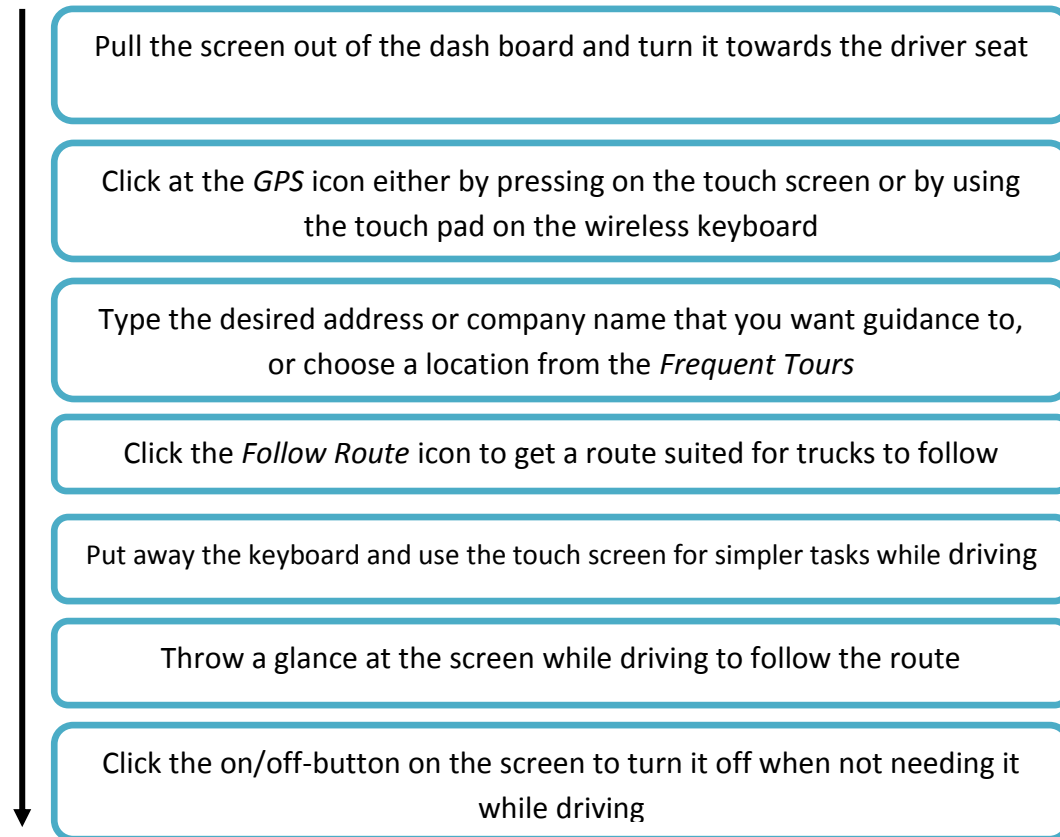
5.6.1.1 Chat



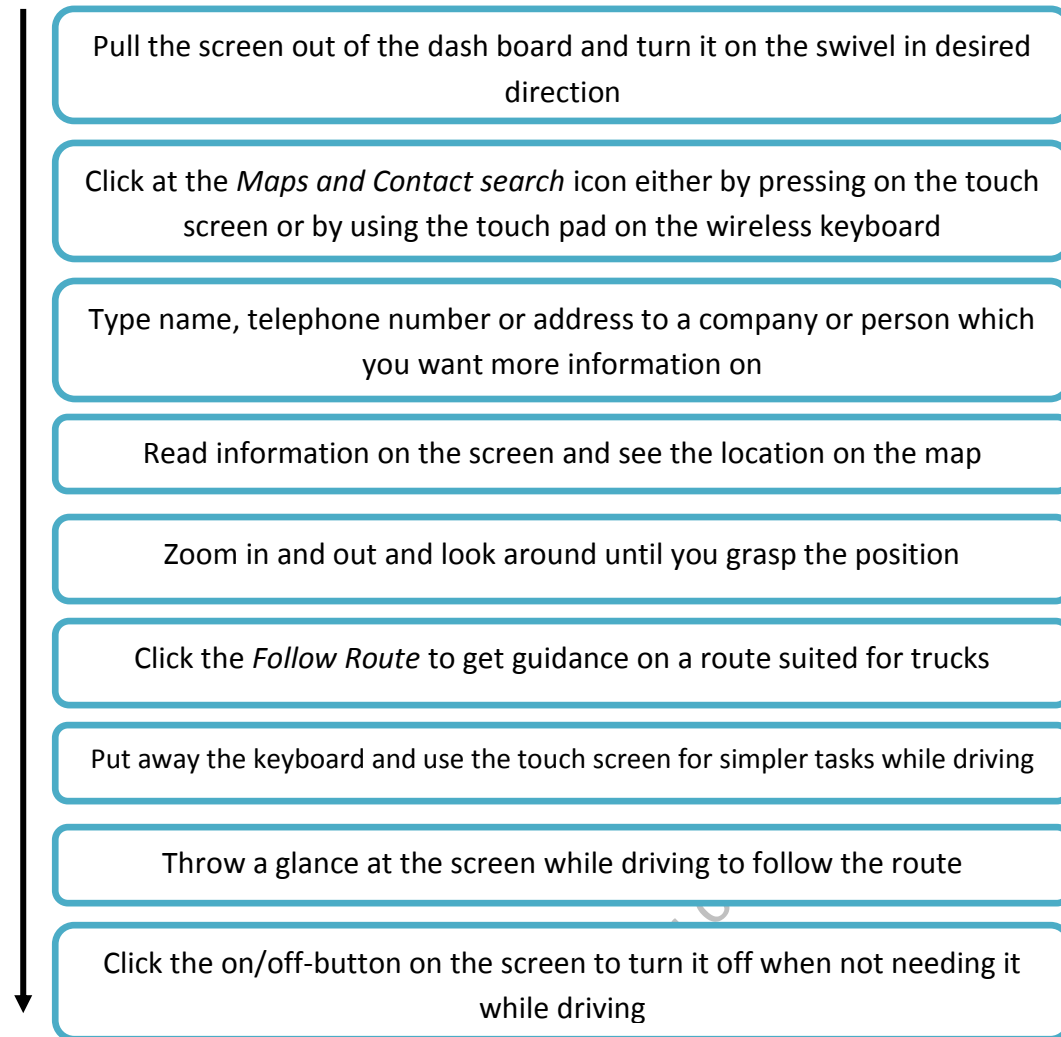
5.6.1.2 E-mail



5.6.1.3 Using GPS



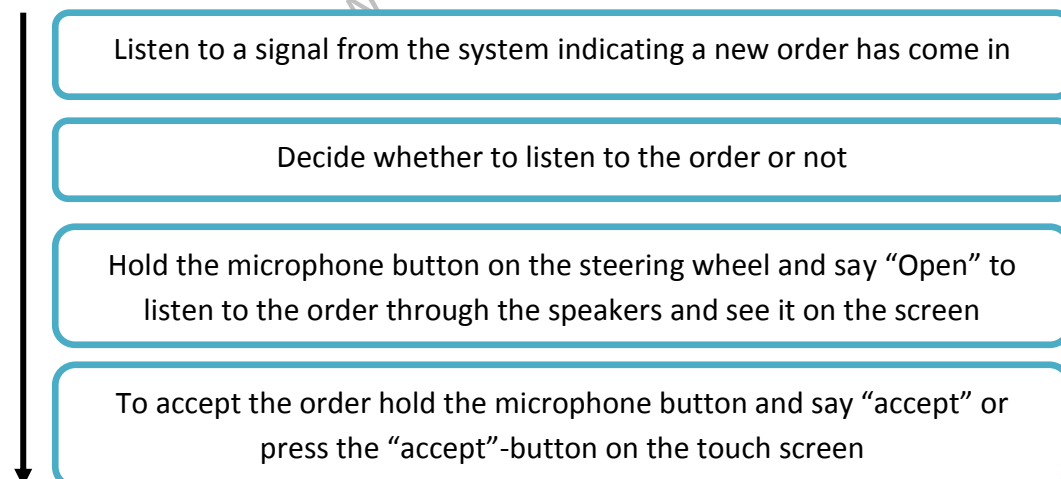
5.6.1.4 Using online maps and GPS



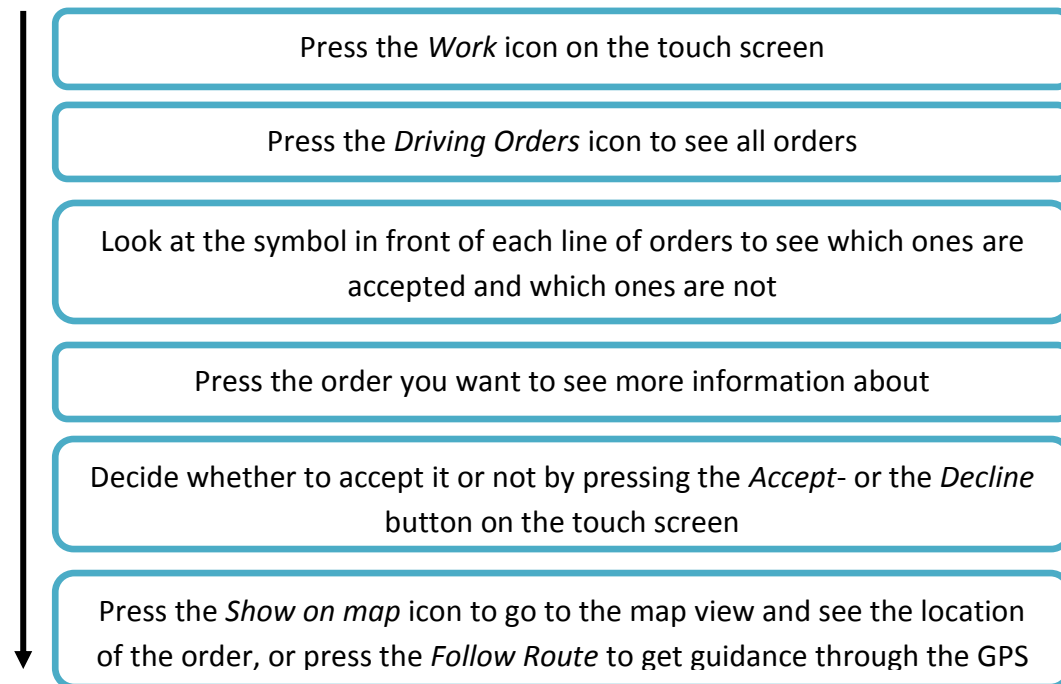
5.6.2 Kjell

Task flows for the different applications that Kjell needs.

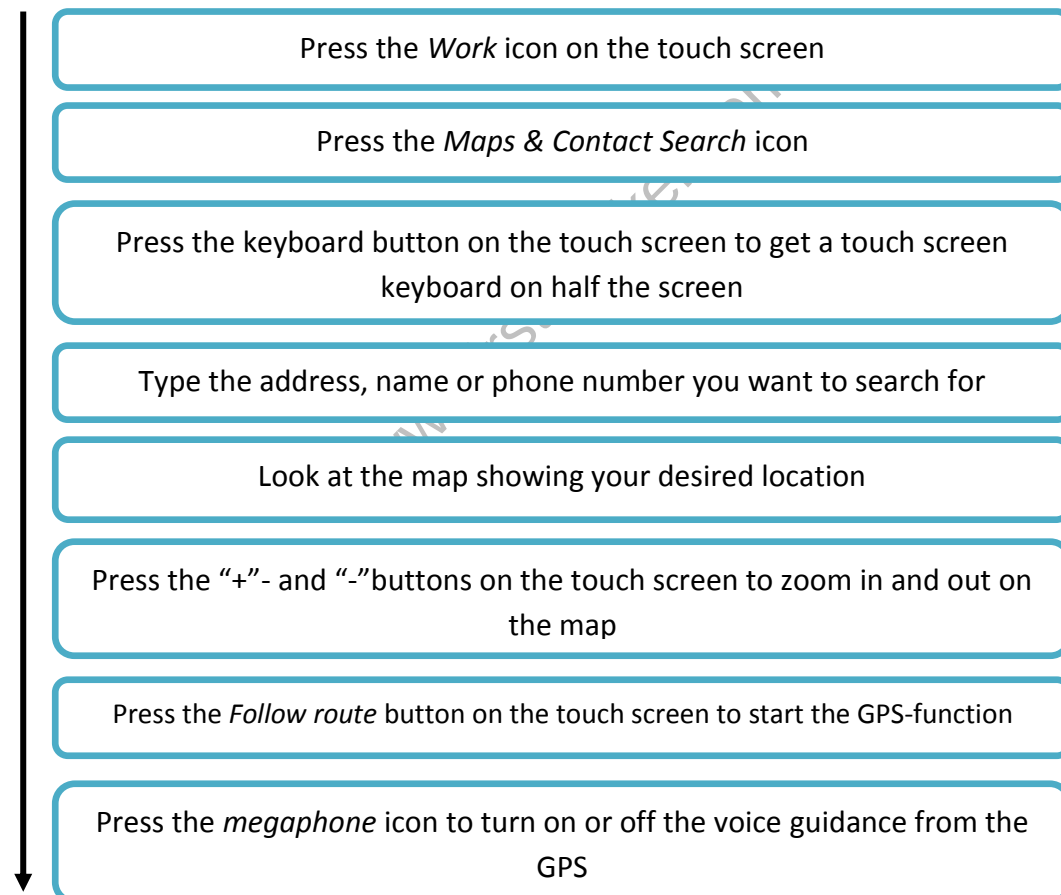
5.6.2.1 Accept new order with voice command



5.6.2.2 See orders



5.6.2.3 Use maps and GPS



5.7 Scenarios

As a final way to introduce the concept for the system for using the Internet in the truck two scenarios are presented to show an example of how Mats and Kjell are using the system a typical workday.

5.7.1 Mats

Mats wakes up in his truck after a night sleeping at a truck stop in the north of Sweden. After finishing his morning routines he sits in the driver's seat and presses the on/off-button above the screen in the dashboard. He pulls the screen out on its swivel arm a little bit and directs it towards himself. His first stop of the day will be "Tures järnhandel" in Axamo near Jönköping. He doesn't know exactly where the company is located and he doesn't have the entire address, so he presses the *Work* icon on the touch screen, presses the *Maps & Contact Search* icon, brings out the wireless keyboard from the glove box and types the company name and Axamo in the search field. A point on the map of the company's location is now displayed on the screen. Mats reads out the complete address and zooms in and out on the map a couple of times to get a good picture of where he's going. Then he turns the screen off and starts the engine. There are several kilometers left before he reaches Jönköping so he doesn't need the *Follow Route* function yet.

After a couple of hours on the road, Mats is getting closer to Jönköping. Now he needs some help in finding the way to the company in Axamo, located west of Jönköping, so he presses the on/off-button above the screen again and the screen shows the same picture as when he earlier turned it off, namely the map showing the location of "Tures järnhandel". He's still on the freeway and this maneuver only requires him to press the touch screen twice, so he feels safe doing it while driving. In the right bottom corner of the screen there is a little icon for the *Follow Route* function. All he needs to do now is to press the icon and then the follow route function through the GPS starts and he can see and follow the correct way to "Tures järnhandel". The GPS or follow route function is adapted to trucks, so it leads Mats to roads suitable for trucks, with no low bridges etc. The screen is 11 inches so it's easy for Mats to see the route from his place at the driver's seat.

Mats continues his workday and by six o'clock it's time to stop for the daily rest. He pulls over to a truck stop he's visited many times before. After eating and taking a shower at the truck stop he goes back into his truck and turns the system screen back on again. This time he wants to feel more relaxed, so he sits in the bed behind the seats and pulls the screen out on its extension swivel arm. He gets the wireless keyboard, puts it in his lap and sits back. Now, since he's leaning back towards a pillow against the wall he's only using the keyboard and the touch pad to navigate in the system. He uses the touch pad to click on the *Private* icon, types his password, and then clicks the *Chat* icon. When the program opens he sees that one of his sons is online, so he clicks on his name to get the dialog box open and starts

typing a message. Mats is chatting with his son, and with a friend who was also online, for a while and before going to bed he decides to check his e-mail. So he uses the touch pad again to click on the *E-mail* icon. When the program opens he sees a new mail from his wife in the in box. He clicks on it to open and read it, and sends an email back before shutting down the program, turning off the screen and putting away the keyboard. He goes to bed and looks forward to drive home tomorrow night for some days off.

5.7.2 Kjell

Kjell just got a new integrated system for the Internet in his truck. He has never really been interested in using the Internet in the truck, and barely uses it at home. But he thinks this new system is good for his work tasks. He starts his working day by turning on the system screen, presses the *Work* icon, and presses the *Driving Orders* icon on the touch screen in the dash board. Here he can see all the orders collected in a list sorted by time to be carried out. He thinks it's much easier to keep track of all the orders now when they're all collected in the system, in comparison to before when he got the orders in text messages on his mobile phone or by phone calls. It's also quieter in the truck today, not as many phone calls with information, since he gets all the information about the different orders by pressing the touch screen.

The order on the top of the screen shows that Kjell is going to pick up timber from a company in Värnamo as his first work task today. He presses the order on the touch screen to show some more information about it. Now he reads from the screen the address of the company, the telephone number, what time he's expected to be there, how much timber he's going to pick up and where to deliver it. He presses the *Show on map* icon and gets to see the company's location on the map. Kjell still feels a little insecure on the best way to get to Värnamo and decides to use the *Follow route* function. He presses the *Follow route* icon that activates the function and also turns on the sound by pressing the *megaphone* icon. He likes to get the information from the GPS read out loud, so that he can keep his eyes and focus on the road.

Kjell started his day in Malmö in the south of Sweden. Now he's driving north, and when he just passes Örkelljunga he gets a little sound signal from the system indicating that a new order has just arrived to the system. Kjell feels calm and he is driving on a good way, so he decides to listen to the new order that the signal indicated. He pushes a button on the lever next to the steering wheel which activates a microphone and says "Open", and then releases the button. Now some short information about the new order is read out loud from the systems speakers. He gets to hear what type of goods the order concern, where and what time to load it and unload it. He knows right away that he will be able to carry out the order so he presses the microphone button again and says "Accept". He appreciates the quick and easy communication, and that the office now knows right away that he will be able to carry out the order, and they don't have to call him. When he stops the next time he will take a

closer look at the order information, but when he's driving it's very important for him to focus on the driving task.

He continues his way towards Värnamo, and the GPS voice guidance leads him all the way to the timber company where he picks up the goods, eats some lunch, and then continues to his next destination.

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6 Discussion

The aim of this study was to investigate what needs long haul driver have for using the Internet in the truck, and what kind of device that would best suit their needs. In this part each research question is discussed in relation to the results and the background, followed by a method discussion.

6.1 What are long haul drivers' needs for a web browser in the truck cab?

There are many different fields of applications of the Internet that the truck drivers are interested in, or in need of. The questionnaire study showed that there are no specific fields of applications that the majority of drivers want, rather the needs and desires include a large amount of different fields of applications.

The interview data showed that the drivers already using the Internet in the truck today mostly use it for FB and map sites. This correspond to the data from the questionnaire study where the field of application indicated as most important was information on maps and roads, and where contact with family and friends were listed at the fourth most important application. Hence they have needs for using both work related and private applications of the Internet.

6.1.1 What fields of applications of a web browser do they need?

Looking at the results from the questionnaire study the amount of different fields of applications that the drivers find important is high. The interview study also shows that the needs for different applications vary among different drivers. The drivers who already use the Internet today are interested in using a lot different applications, whereas the drivers who're not using it in the truck today only want to use a few different applications, mostly work related. This is the reason for designing the concept in a way that makes it possible for each driver to decide which applications he wants to install in the system.

The voice of the customer gets more focus in today's product development to increase the likelihood of satisfied end customers (Ullah & Tamaki, 2010). And according to the Kano model one should keep the must-be attributes, add several one-dimensional and attractive attributes, avoid as many indifferent attributes as possible, and avoid all reverse attributes to satisfy customer needs. The function analysis of the questionnaire study shows which applications that are necessary and should be kept as must-be attributes. From the interview study the general impression is that all work related applications can be seen as must-be attributes, the connection between GPS, online maps, and the order program as attractive attribute, and the personal applications as one-dimensional or attractive (Ullah & Tamaki, 2010).

6.1.2 In what situations do they want to use a web browser?

Almost all the drivers have stated the importance of keeping focus on the driving task, and most of them want to use private applications only at nights before going to bed in the truck. The need for availability during day, and sometimes while driving, is bigger among the work related applications than the personal applications. Applications such as the order program and the GPS are applications that many of the drivers prefer to use while driving. The online maps and the search function are preferred to be used just before starting to drive and to have a quick look at while driving.

The reason for designing a lock function on some of the applications is that the control in the system should not be lost. According to Hollnagel and Woods (2005) activities on a higher level of control might worsen performance on a lower level of control. It will be important to study what effects different kinds of application will have on the driving task before allowing them to be used while driving. To start with, the limitation could be to let all personal applications be locked while driving, and allow some of the work related applications, like using the GPS, driving order program etc. that are already being used in today's systems.

6.1.3 Are the needs different for work related uses and private?

The biggest difference is that almost all drivers are in need of work related applications, whereas the needs for private applications vary more. The data from the questionnaire study shows that the drivers classify work related uses of the Internet more important than personal uses.

The work related applications suggested in the concept in this study are in many ways similar to applications and programs that exist in on-board computers today, for example in Dynafleet, like GPS, driving order program etc. An important advantage with the concept in this thesis is that the drivers get a connection between the driving orders, GPS and online maps. This gives them a better overview of the situation and simpler work tasks, since they for instance can get information from a driving order, or from the online maps, transferred to the GPS and start the guidance or Follow route function.

Roy (2001) describes that in as early as the 90's haulage managers ranked information and communication technologies as the most important factors of success in their business, and Golob and Regan (2005) defined information on locations of freeway incidents and lane closures, weather information, and travel times on alternative routes as the information that haulage managers find most important for their drivers to have access to. Using information and communication technology in the trucks has clear benefits for haulage firms in terms of lower communication costs and efficiency of goods movement etc (Roy, 2001, Golob & Regan, 2005). Further improving the possibilities for drivers to use the Internet for work related tasks should consequently be of interest for haulage managers. Some

possibilities have been presented in the concept in this thesis, for example the possibility to connect the GPS functions, driver order functions and online maps.

According to the JCS theory (Hollnagel & Woods, 2005) what defines a JCS is the ability to stay in control in the situations where it has to function. A major part of being in control is to be able to reach the system goals. When it comes to the JCS described in this study, i.e. the driver, the truck, and the system for the Internet, the JCS approach works well for the work tasks of the JCS. It feels natural to talk about control and goals when it comes to work tasks, like keeping track of the driving orders, or reach a specific location in time. However, when it comes to the non work related tasks of the system, the JCS approach is not as obvious to use. The ECOM model is easy to apply to the work related tasks, but not as easy for the non work related tasks.

Hollnagel and Woods (2005) mention that it's important to make a distinction between the JCS and its environment, and that the dividing line between them can change depending on for example what the focus of the analysis is. This becomes very clear in this study when comparing the work related uses of the Internet and the private. The dividing line between the system and its environment move between inside the truck and outside it. When looking at the JCS and the work related tasks the line defines the JCS system as the driver, the truck and the system for the Internet and the environment outside consists of the roads and other road users etc. However, when looking at the JCS and the private uses of the Internet, it's more natural to only include the driver and the system for the Internet in the JCS, and the truck as the environment, since the truck is generally standing still when the driver is using the private uses, and the environment outside the truck consequently does not affect the JCS and the JCS does not affect the environment (Hollnagel & Woods, 2005). This shows the important of defining the system and the environment when designing a new system. Different uses of the same system can move the line between the JCS and the environment, and thus change the conditions where the JCS has to function and be in control.

It's also not as obvious to talk about *control* when it comes to the private uses as when it comes to the work uses. For the work tasks there usually is an obvious and explicit goal that the system has to reach, since almost all kinds of work often is based on different goals to reach. In this study it can be for example to deliver specific goods at specific places at specific times. To reach these goals control over different things is needed, like control over the speed, over the destination etc. This also makes the ECOM model natural to use, since it shows control at different levels which are active simultaneously. Regarding the private tasks that the driver can use the Internet for it's not as natural to talk about control in the JCS, neither to talk about goals, since the "goal" is often to just kill some time at nights. One goal could be for example to stay in touch with the family at home. Here the goal is clear, but it does not feel as natural to talk about being in *control* of the activity of staying in touch with the family.

The ECOM model and the JCS approach seem to be most natural to use when it comes to work activities. In these cases the control is very important to reach the system goals, i.e. to complete the work tasks. It's also an important safety aspect to be in control at every level. Even though the JCS system approach and the ECOM model can be used for the private activities as well it doesn't feel as vital. To be in control of the private activities might not be as necessary as of the work related activities. To temporarily lose control over the activity of staying in touch with the family (e.g. through a chat client) does not cause as devastating consequences as for example to lose control over the driving task. The state of being in control when it comes to the private uses seems to be more connected to the usability and user satisfaction than to safety. So here it might be more natural to use the Kano model than the ECOM model. Thus, both the ECOM model and the Kano model works for both work related tasks and private, but the ECOM model might be somewhat more suitable for work tasks and the Kano model for private tasks.

6.2 What kind of device is best suited for long haul drivers' needs for using the Internet in the truck cab?

As Stevens (2000) points out any new system installed into a vehicle may affect safety in a positive or negative way. Any new system can change the existing relationship between the driver, the vehicle, other road users, and the road environment. This is also highlighted in the JCS theory (Hollnagel & Woods, 2005), which says that any activity at any layer of control in the JCS can affect control on the other layers. Therefore it's important to consider aspects of the whole JCS, when designing a new system (computer) in the truck, i.e. the joint human-computer-truck system. A new system for the Internet in the truck cannot steal attention from the driving task, i.e. a system which demands activities at a higher level of control should not risk to minor control at a lower level, for example the control of the driving task. This is why it's essential with strict investigations on what application that demands too much attention from the driver, and should be locked and not available while driving. One way of doing this would be to use the list of principles of design of information and communication systems described by Stevens (2000).

6.2.1 How should the interaction with the device go about to best suit the drivers' needs?

The drivers mostly prefer a touch screen for using the Internet in the truck, although some of them would like to use voice control for the driving order program. They also want a wireless keyboard to use at nights when standing still. According to Stevens (2000) the most unsafe part of talking on the phone while driving is the dialing part, since the use of buttons results in divided attention and changes in the direction of vision. Perhaps not only the driving order program could be used by voice control, but also some of the navigational tasks, like using the maps and GPS. By using voice commands the attention does not have to be directed

away from the road, which should lead to safer driving. If a good way of using voice control was developed maybe some more of the applications could be unlocked while driving.

The JCS in the case of work related tasks performed on a system for the Internet in the truck can be seen as *the driver, the system for the Internet, and the truck*. This since the work applications probably will be used a little while driving which makes the context the roads and the other road users. When it comes to the private uses of the Internet in the truck the JCS can be seen as *the driver and the system for the Internet*, since the applications will probably be used mostly when standing still. This makes the environment the inside of the truck cab. The fact that a JCS must maintain control in an unpredictable environment (Hollnagel & Woods, 2005) is another reason why the interaction with the system cannot steal the driver's focus from the roads. To be in control is for the JCS to be able to reach specific goals (Hollnagel & Woods, 2005), and the goals of the JCS consisting of *the driver and the system for the Internet* could be for example to stay in touch with the family at home. While the goal of the JCS consisting of *the driver, the system for the Internet and the truck* could be to reach a specific goal at a specific time.

6.2.2 Where should the information be presented?

The drivers want the information from the Internet to be displayed on a rather large screen in the dashboard. They want to be able to watch movies, look at maps etc. and see the information clearly, which demands a larger screen. They also want to be able to see the information on the screen from many different places in the truck, which makes a swivel screen suitable. Maybe the screen should even be able to remove and place in different holders at different places in the truck.

Many of the drivers themselves state that the screen shouldn't be placed too high since it would cover the visibility of the road. As Stevens (2000) points out any new system installed into a vehicle can change the existing relationship between the driver, the vehicle, other road users, and the road environment, which is a reason to consider the JCS also when it comes to the placement of the information.

6.3 Method discussion

Data triangulation was used by collecting data through both questionnaires and interviews and comparing the results. It was also used by letting other people than the interviewer analyze the data through the interpretation workshops.

A problem with the use of interviews is the possibility that the interviewee is not completely truthful, or says what s/he thinks the interviewer wants to hear. Having just one interviewer can be both positive and negative. The positive side of it is that all the interviewees get the same treatment. But by having two interviewers the results could've been compared to see if the interviewees' answers were affected by the interviewer. An alternative to the

interviews would be to perform a completely anonymous questionnaire study. But this would rule out the possibility for follow-up questions, and the data would most probably not be as rich.

The interviews were held in a room next to a restaurant at a popular rest stop for truck drivers, which made it a quite natural environment for the drivers that participated in the interviews. But if the interviews would've been held inside the drivers' trucks, it may have helped the drivers even more to think about their needs and desires about using the Internet in the truck cab, and about what sort of system they would want to use.

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7 Further research

Conducting this study gave rise to some suggestions to further research.

By simulation studies different safety tests could be made to decide which applications that should be locked while driving the truck, and which applications and tasks that could be performed while driving. Simulation tests could also give more information on how the system for using the Internet should be designed to be safe to use while driving and not risking stealing attention and losing control on different levels according to the ECOM model.

After simulation studies, when designing a more developed concept it would be very interesting to test the concept through field studies where drivers could test and evaluate the system. By involving the drivers in the concept design, and letting them make evaluations, would increase the chances of a system suitable for the users and their tasks and needs.

Another interesting study would be to find out how the goals of following the driving and rest time rules is in conflict with the goals of keeping to the strict time schedule to reach the customers in time, and how a potential system could be used to supply a solution to this conflict.

8 Conclusions

Using the Internet in the truck for different work tasks could be a good investment for profitability of the haulage firm, and make the drivers' work simpler. By also applying personal applications suited for the drivers' interests they could be more satisfied with their work situation by having something to do at breaks and at nights before going to bed in the truck. By using a system where the drivers themselves can choose which applications they need it would be easier to make each driver satisfied.

When designing a new system it's important to realize that the human and machine strive for the same goals, and to consider the limitations of both the human part and the machine, and take advantage of the difference in the design to get as good performance possible of the JCS. This means to keep control of activities at every level, and reach the goals of the system.

To bring the future customers and users of a product in to the design process also makes the possibility of designing a system that will work well. This can be done by a goals-means analysis.

The greatest difference of the concept presented in this thesis compared to the systems being used today is the connection between the GPS, the online maps and the driving order program which would make the drivers work simpler, the possibility to choose among different personal applications to use, and the possibility to use voice control.

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Attachment 1. Questionnaire

Questionnaire – fields of applications of the Internet in the truck

My name is Regina and I am writing a thesis on truck drivers needs in being able to use the Internet in their truck.

Below are a number of different fields of application of the Internet listed. For each different field of application, mark how important you think it is to have access to that field of application in the truck, by circling a number between 1 and 6.

Number 1 stands for *Not at all important*, and **number 6** stands for *Very important*

If you think some field of application is missing, you can fill that out in the bottom rows marked with *"Other"*. If you choose to fill in one or more other fields of applications, please also indicate how important you think these are by circling a number.

You are totally anonymous in the survey and data will be compiled in a way which makes it impossible to trace them to specific individuals. Only aggregate data will be printed in the study report.

Thank you for your participation!

Regina Johansson

Cognitive Science

Linköping University

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Indicate how important you think it is to be able to have access to the following uses of the Internet in the truck.

Number 1 stands for *Not at all important*, and **number 6** stands for *Very important*

1. Keep in touch with fellow workers/colleagues

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

2. Keep in touch with friends and family at home

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

3. Keep in touch with dispatcher/hauler

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

4. Reading online newspapers

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

5. Finding information on weather and road conditions

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

6. Play online games

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

7. Finding information about traffic queues on the roads

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

8. Watch Web TV

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

9. Handle order lists

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

10. Reading and/or Write blogs

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

11. Finding information about traffic accidents

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

12. Working with your own web site

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

13. Finding maps and information about roads and paths

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

14. Listen to Web radio

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

15. Finding information about rest areas, restaurants and gas stations

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

16. Using Social Networks

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

17. Finding information on ferry time tables

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

18. Download games, pictures, movies or music

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

19. Finding technical information about the truck

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

20. Finding information about the city you are in

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

21. Finding Health Information

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

22. Download software

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

23. General information search (through a search engine)

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 *Very important*

24. Other: _____

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

25. Other: _____

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

26. Other: _____

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

27. Other: _____

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

28. Other: _____

Not at all important 1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 Very important

Other

☐ Man ☐ Woman

Age: _____

In which country do you live? _____

Number of years as a truck driver: _____

Type of transport:

☐ Long Haul

☐ Construction

☐ Distribution

Number of years as a long haul driver: _____

What brand is it on the truck you usually drive?

☐ DAF

☐ Renault

☐ Iveco

☐ Scania

☐ MAN

☐ Volvo

☐ Mercedes

☐ Other: _____

Model: _____

Model year: _____

How many nights per week do you sleep in the truck? _____

Do you own your car or drive for a haulage firm?

☐ Own car

☐ Haulage firm

☐ Other: _____

Do you use the Internet in the truck today?

☐ Yes

☐ No

If yes: In what way?

☐ Laptop

☐ Smart phone

☐ Other: _____

If yes: What is your main field of application of the Internet in the truck today?

Do you ever use the Internet when you're not in the truck (e.g. at home)?

☐ Yes

☐ No

If yes: How many hours per week? _____

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Attachment 2. Interview template

1) Do you use the Internet in the truck today?

If YES:

a) Thought what kind of device? (e.g. laptop/smart phone/iPad)

b) What do you use the Internet for? Both work related and private uses.

c) Questions to each field of application the driver mentions:

i. Why is that important/interesting?

ii. When?

While driving?

Short/long breaks?

iii. Where?

Where inside the truck?

Outside of the truck? At truck stop?

iv. How?

How do you think it works? Why?

How do you want it to work/to be used? Why?

Anything that could be better/simpler than today?

d) Is there anything you would want to use the Internet for that you don't do today? (e.g. due to lack of equipment/device). Both work related and private uses

i. Why is that important/interesting?

ii. When?

While driving?

Short/long breaks?

iii. Where?

Where inside the truck?

Outside of the truck? At truck stop?

iv. How?

How does it work today?

How do you want it to work/to be used? Why?

e) You mentioned you use X (e.g. laptop/smart phone) to use the Internet today;

- i. Would you want to use the Internet through any other device?
- ii. How would you like to interact with the system?
- iii. Is there anything that could make it better/simpler?

If NO:

f) Would you want to use the Internet in the truck?

If yes:

- i. Why do you not use the Internet in the truck today?
- ii. What would you like to use the Internet for? Both work related and private uses. Questions to each field of application the driver mentions:
 1. Why is that important/interesting?
 2. When? While driving?
Short/long breaks?
 3. Where? Where would you want to be when using it?
Where inside the truck?
Outside of the truck? At truck stop?
 4. How? How would you want it to work/to be used? Why?
Through what kind of device?
Anything that could be better/simpler than the devices being used today?

If no:

- iii. Why not?

2) Do you get any device from you firm/hauler?

a) How big is the haulage firm?

3) Is there any other kind of system in your truck that's not used through the Internet? E.g. something used to handle driving orders or looking at maps or keeping contact with the hauler?

a) What is it used for?

Questions to each field of application the driver mentions:

1. Why is that important/interesting?

2. When? While driving?

Short/long breaks?

3. Where? Where inside the truck?

Outside of the truck? At truck stop?

4. How? How do you think it works? Why?

How would you want it to work/to be used? Why?

Anything that could be better/simpler?

4) What kind of tasks do you think one can perform while driving, beyond the actual driving task?

a) What tasks are too complex?

b) When can you feel distracted/unobservant?

c) What do you think is important for the work to function well?

i. What's important for you to feel that your work situation is under control?

1. Why?

ii. What's important for the work to function smoothly?

1. Why?

d) What do you want to be able to affect yourself in your work?

i. Why?

5) Is there any integrated (built in) system for using the Internet in your truck today?

If YES:

a) What is it used for?

Questions to each field of application the driver mentions:

1. Why is that important/interesting?

2. When? While driving?

Short/long breaks?

3. Where? Where inside the truck?

Outside of the truck? At truck stop?

4. How? How do you think it works? Why?

How would you want it to work/to be used? Why?

Anything that could be better/simpler?

b) Do you see any benefits of an integrated system?

If NO:

c) Would you see any benefits of an integrated system for using the Internet in the truck?

i. Would you want to have an integrated system for using the Internet in your truck?

If Yes:

ii. Where would you like the information from the Internet to be presented?

iii. How would you like to interact with the information/the system?

iv. What would you like to use it for? Both work related and private uses.

Questions to each field of application the driver mentions:

- 1.** Why is that important/interesting?
- 2.** When? While driving?
 Short/long breaks?
- 3.** Where? Where would you want to be able to use it?
- 4.** How? How would you want it to work/to be used? Why?

If No:

- i.** Why not?
- ii.** Is there any single field of application that you would prefer to use on an integrated system for the Internet in the truck
 - 1.** What field?
 - 2.** Why?

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