Designing future interaction with today's technology

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Abstract

Information Technology has an increasing part of our lives. In this thesis we will discuss how technology can relate to humans and human activity. We take our standing point in concepts like Calm Technology and Tacit Interaction and examine how these visions and concepts can be used in the process of designing an artifact for a real work practice.

We have done work-place studies of truck-drivers and traffic leaders regarding how they find their way to the right addresses and design a truck navigation system that aims to suit the truck drivers work practice.

Key Words

HCI, Design, Work Practice, Calm Technology, Tacit Interaction

Hello!

Welcome to this master thesis, made with blood, sweat and tears by Johannes, Martin and Mårten. We have been using an interaction paradigm, Tacit Interaction, and a technology design vision, Calm Technology in a project designing a tool for truck navigation.

We have designed this thesis starting with an **introduction** of what we have done and what our philosophy is. We then, in the **background**, question what a computer is and write about tags—a way of interacting with the computer. From tags we go over to present the Paper Palette, since tags is an important part of that concept, and from the Paper Palette concept it is not hard to uncover our vision about the future computing.

Built on our visions about the future computing and our knowledge about the Paper Palette we have come up with two ideas in the area of car navigation and music listening. Before the empirical part, which is about our comprehensive field studies on truck drivers at the contractor haulage 'Karlshamns Expressbyrå', we describe our ideas, NaviMap and TitleTag in more detail.

The **empirical** part reveals our insights in the profession of being a truck driver, insights that are invaluable when making our design of NaviMap—the great navigation system for truck drivers. The **design** of NaviMap and TitleTag is based on our knowledge of the latest existing technology in a way it fits into the use area. The way this belongs together we then discuss in the **reflection** part, where the concepts Tacit Interaction and Calm Technology are set in relation to NaviMap and TitleTag. At the end the ruin is near. The final countdown has started and we finally reach the goal and our **conclusion**.

We wish you a merry reading and a happy new insight in the design of future interaction with today's technology.

Read and be astonished!

Ronneby in May 1999

Johannes Agardh Martin Johansson Mårten Pettersson

The authors and the work

In the beginning we worked together, divided, with literature studies and tried to get individual ideas for a common area of application. Each of us was responsible for contacting different companies and organizations. When writing about the ideas Johannes wrote about one, Martin about the other, and Mårten about the future computer concepts.

When we today compare what we wrote then with what it says in the report, it is not very much that is the same. It is no longer easy to see who wrote what. Our working process has been so interweaved that the text belongs to all three of us.

Below we will write little about our own favorites, the things we are proud of.

Johannes: To mention something that has been my favorite experience, and something I am proud of in this project, must be from the empirical part. The experience from travelling with the truck-driver Henry and then analyze that material in comparison with the others, has been very interesting and fruitful. Also the reflections and connections in the area information overload, in relation to Tacit Interaction and Calm Technology, is something I proudly present.

Martin: The most important part of this thesis is the human-computer relation. I believe that we have come rather far in our discussions about how tangible user interfaces can be used to achieve a good environment for the user or users. The favorite parts of what I have written is about the use of and relation to technology, and about how design and work practices can come together.

Mårten: I am proud of the empirical part of this project regarding both the field-observation and analyze of the material back home. I feel that the days with Joey and Perry gave me a valuable insight in the truck-drivers workday. In the process of working with the field material the writing of the empirical chapter of this thesis is included. Working with the field material and trying to connect it to the final design suggestion is one of the things I feel is the most interesting from this project. I also think that the project has given me an opportunity to work with the concepts of ubiquitous computing, calm technology and tacit interaction in a way that I perhaps could not have done if doing a project in the desktop metaphor area.

And of cause we are all very satisfied with the work for this thesis as an entirety.

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Introduction

What we have done

In this paper, our master thesis, we will discuss how information stored on physical objects, 'tags', together with computational power can be used to achieve an unobtrusive way of interaction. Two examples of use areas—music listening and car navigation—will illustrate the possibilities and advantages with this technology. Our main interest is *use* of and *interaction* with information technology. Our findings are based on actual work practices examined with ethnographic methods.

In the area of Human Computer Interaction the graphical user interfaces have been the main focus (Winograd, 1996). We will accompany those, who has gone a step further using physical interfaces (Ishii & Ullmer, 1997, Weiser & Brown, 1996, Nelson et al, 1999, etc). We will examine what some ideas about tangible bits and graspable interfaces can be used for in the purpose of Tacit Interaction and Calm Technology. The example product, the Paper Palette, described in the article that introduces the paradigm Tacit Interaction, has inspired us.

Our philosophy

Use as ground

The television set is a fantastic invention, the world takes a step in to your living room and all you have to do is to press a button on the remote control. Imagine that you are sitting in your armchair just finished reading a good book. You might wonder what has happened in your local area today. The only thing you have to do is to turn the TV on and wait for the news. But hey, *wait*, is it waiting you wanted? Depending on how one look at the purpose of an artifact, the design can be more or less good. Now, the digital TV is about to enter our homes and change our way of using the medium. Besides the better sound and picture quality, the digital TV is designed in a way that will give us the possibility to choose when we want a show to start. This option gives the prospect of changing the TV habits and the *practice of* TV *use*. The digital TV will be more like a newspaper, one uses it when one have got the time and not when it arrives in the morning. We will not say whether this change is good or bad, because we believe that it will differ from one situation to another. We look at it as an example of how a technology changes the space for action and changes our lives.

A part of our philosophy is that when we look at an artifact, we see the people who will benefit from the *use* of it. We try recognizing what kind of support the artifact might provide for them. We try to see the whole activity, rather than just

look at isolated tasks. Engeström explains an activity system as:

"The activity system of a workplace comprises the individual practitioner, the colleagues and co-workers of the workplace community, the conceptual and practical tools, and shared objects as a unified dynamic whole" (Engeström, 1994 p.237)

When introducing a new technology into an activity system the practice will be changed. The change may be more or less good for a particular situation. Our way of handling this is to do good design work based on empirical studies. Technical things should be useful, easy to handle and match the activity, and therefor we do design.

To know if an artifact is useful, easy to handle and matches the activity we try to observe the use of it in its natural settings and situations. How the artifact is actually used, and how it is designed to be used, may differ. In those cases observing the real use can give valuable feedback to the designer on how design makes the artifact support the user in a, for the user, satisfying way. Since the artifact is designed to support the user in performing some sort of a task the designer has to understand what the user is doing.

Design as means

In our terms to do good design work includes understanding the work practice. The designer has to come up with solutions that later are anchored in the activity. To support use through design includes that you have to understand the environment in which the use will take place. As designer one can observe and interview the user. But it is the user who knows the history, the tradition and he knows *why* and *how* something should be done. By talking to the future user and by studying the work and the workplace, the designer gets a picture of the environment that is good enough to continue doing a design. When the designer describes the design, the user can question it and in that way inspire the designer to go on with the design. Then, the future user and the designer together can continue develop an artifact well suited for its purpose.

It is easy to see what a practitioner does but to understand the reason for the action you need background knowledge. As an observer you interpret what you see and make assumptions due to your previous experiences. "The observer sees the same behavior but cannot know what it means without asking the user" (Nardi, 1996 p. 12). To be able to understand what the user is answering you have to learn the professional language of the user, for example which terms he uses when talking about the actions.

The new technological solutions are applied when needed and if it is not suitable it will be thrown away. It is the designers that are responsible for the end-result. Although the user participates, the design decisions are to be taken by the designer. The designer has to be conscious about what the decision means for the end-result (Winograd, 1996 p. xx). To improve a situation you have to change it. Design is for us a mean to change the situation into a preferred one (Schön,

1991 p. 46). What 'preferred situation' means differs from design to design but you may have some ideas about what is preferred in a specific situation. Those ideas may be grounded in experience from other design situations that we have experienced. Our experience from designing tells us that we feel when a 'preferred' situation has been reached. It is difficult to state in advance exactly what a preferred situation is.

How we see the technology

The designers' role is, among other things, to be aware of the future possibilities of the technology and present them to the users (Ehn, 1991 p.172). The technology sometimes has something that appeals to us as designers. In the case of the Paper Palette (Nelson et al., 1999) the way of using existing technology and changing the way of working with it made us interested. The main thought behind the Paper Palette is to control a Microsoft Power Point[1] presentation using physical objects, paper cards, and thereby being able to do the organization of the presentation uncoupled from the computer. We think of the Paper Palette as a *generative metaphor,* a term borrowed from Donald Schön (Schön, 1991 p.185). It is generative in the sense that it gives us new ways of thinking about interaction with computers or computational power.

[1] Microsoft Corporation copyright 1997

By using tags, of some kind, one can take one step away from the computer as a desktop metaphor. One step that we believe is in the right direction from a use-point-of-view.

[…] the [third computer] generation where the technology disappears into the tool, serving valuable functions, but keeping out of the way. (Norman, 1998 p.259)

The desktop computer is great for some use areas, but not for all. When the computer is built into a tool, or an environment, numerous of features can be added. An example is a kitchen ranges, when one forget to turn it off the computer can notice it and take action.

Sometimes the technology can be seen to give the designer new ideas about what to do, and new technology can be used in new design situations. Other times the idea comes from the designer and the technology then is developed to fit the idea. As designers we can see the technology as enabling, something that makes our design ideas possible to come through. At the same time as we want to make the possible stuff we question how far we can go and if it is necessary to go that way.

"Applications in which some people benefit at the expense of extra work for others are unlikely to be successful. […] It comes unstuck in most cases because it does not take the practical work process of all *staff members into account."* (Robinson, 1993 p. 32)

When seeing technology we try to be aware of how it will affect integrity, looking for example on surveillance and control capabilities, since those aspects of technology use are important for us.

Background

We begin this chapter by writing about computational power. The Paper Palette is designed using the 'old', well tested, barcode technology. Since barcodes are not the only way one can *tag* physical objects, we will go in to this a little bit further. We will also present the Paper Palette in more detail and describe what we find so interesting with the concept.

Computational Power

Computers can be designed for different purposes. They are no longer just on the desktop or in the lap. Computers are everywhere, in different shapes, supporting us in different activities at different times. When we are talking about computational power we are discussing what a computer can be used to and how we can use it. Often there is an interest in how fast a computer is, if it has a 300 or a 550 Mhz processor. That is technical data. Sometimes we are interested in those data because they are telling us something about what is possible to achieve with the computer. Other times the technical specification of the computer is not that important for what we can achieve with it. As designers of information technology we know that there is a need to be aware of what is possible to do, to be able to design solutions that fits the activity to be supported.

In the use perspective we are interested in the properties only if they are limiting what we can do with the computer. The design of a desktop computer makes it possible to do certain things with it, for example writing e-mail or browsing the Internet. At the same time it is limiting other things. To give one example it is quite hard to bring the computer when travelling, or moving it. As a support for writing the desktop computers word processors are splendid. To get an overview the large screen serves its purposes. But when you would like to have other possibilities, for example carrying the computer with you, other designs, for example wearable computers, can suit the purpose better.

Computers are present in for example cellular phones, in fax-machines, in the car and in the whiteboard keeping track of what you write on it. We have them on the desk, in the palm of our hands and in the pocket. They are in devices that are said to connecting people and mediating you when making your self heard. Sometimes you do not think about that you are using a computer for example when talking in a cellular phone. Other times you are very aware about it—more aware than you would like to be.

We accompany those who believe that in the future computers will be everywhere, and that the computers will not be isolated from each other. Today the palm sized Personal Data Assistants (PDA) can be described as down sized desktop computers (Dahlbom & Ljungberg, 1999). Sized down not just regarding physical properties, but also regarding fewer functions. Not everything that you can do with the desktop

computer is possible to do with the PDA. A PDA can be used as a calendar, but perhaps not in the same way as a paper calendar. The PDA can be synchronized with a computer in the local area network, used as a browser for the Internet or as a map connected to the Global Positioning System (GPS) or other positioning systems (for example by using the Global System for Mobile communications (GSM) network as coordinates).

Computational Power is not limited to the desktop, the lap or to the hand (PDA). Neither is it just networks or positioning systems. We are trying to free ourselves from the picture of a computer as a 'desktop metaphor'. When we use the term computational power we talk about advantages of computer use. We prefer the term computational power, power that you can use, in different environments.

Tags

What

When we in this thesis talk about tags, we are referring to the tags that make it possible for computers to track and identify analog things. Examples of such tags are barcodes and magnetic plates. These kind of tags can be attached or built into almost everything and with input devices that are designed for this purpose they can be used as input data to a computer.

Where

A tag can be applied on anything. It, for example barcodes, can be put on an article by a manufacturer, a wholesaler or by an end-user. The purpose might be stockholding recording, pricing, alarm or machine-machine awareness. An example of machine-machine awareness is a car key that contains a microchip that sends a signal to the anti-theft system in the car. The same tag can in different environment be used for different purposes. Still this sort of designing analog things so they can be handled as if they were digital can make the digitalization understandable and most often you do not have to think about the computation.

Obtrusive, conscious or calm

When you borrow a book from the library the barcode tag is visible and obvious. It function as the identifier for the library computer system and when you see the book lying beside your bed the tag might indicate that the book does not belong to you. As long as the tag is not in the way of other information on the book, the tags does not disturb you. The tags that are built in some car keys are not visible. The function is that it should be difficult for a person that not owns the car to make a key copy. If a copy is made in the 'traditional' way, the key will fit the locks but the car will not start. A problem with this kind of calmness is when the technology fail and the car owners do not understand what the problem is, a work-around to solve this problem is to give the information in a display, but a better design would be to make the tag obvious. Maybe it would be enough to put two small copper plates on the

plastic parts of the key. The plates would indicate that the key has some kind of electronic function.

Active or passive

Most of the tags that we use today are passive, requiring a scanner of some kind. An exception is the GPS sender. The GPS sends signals that can be used for positioning and navigation systems. Nicholas Negroponte, director of the MIT Media Laboratory, writes about active labels:

"Why not make each UPC [Universal Product Code] able to radiate data? Or, why not let it be activatable, so that like a child in kindergarten it can raise its hand." (Negroponte, 1995 p.209)

In this way the information can be decentralized. The kindergarten teacher does not have to listen to everything the children are saying to each other, but here she will give the attention to those who wants it.

Centralized vs. decentralized information—different ways of physicalizing

A tag can either contain or refer to data. Here we will explore what makes one way better than the other, or put more correctly, when which suits best.

In supermarkets almost all groceries are tagged with a barcode. The code does simply represent a number that identifies the article in the supermarket's database. This is an example of a centralized barcode system and in this kind of setting it works pretty good, at least for the supermarket. When a price is changed the employees does not have to re-mark all articles, they just change it in the database. For the customer, on the other hand, the barcode is not very useful. The barcode tells the cash registers the price, but when you look at it, it does not even tell you which currency the price is in, unless you find a 'price-checking terminal'. The barcode is constructed for machines.

On a pre-recorded minidisk (MD) the disk is tagged with the artist's name both analogy (it is written on the label) and digitally (stored as bits, on the disk). The information is decentralized and when the disk is inserted in to a player the name of both the artist and the current song is shown on the MD-player's display. The information is not stored in the player but on the disk, which gives that when you put the disk into your portable MD-player the information is brought along. Text labels are suited for human beings.

The advantages of centralized information are that it is easy to update and that contradictions, such as two articles with the same identification number are easily discovered and one of the articles can be given a new number.

The things you gain from using a decentralized information approach are the mobility, the greater varicosity of use areas for each tag, and the robustness (compared with a central storing place) if one fail all the others still work.

The question of centralized or decentralized is a question of use. Sometimes a centralized approach is the best-suited design and sometimes it would be better to have the information decentralized. It is also possible to combine the approaches, with the risk of redundancy.

Paper Palette

The Concept

The Paper Palette concept is about making it possible to interact with a computer by using paper cards. The computer is in the background, which means that the users' focus is not on using it, but to make a presentation. The interaction paradigm explored by the developers, the researchers, in the Paper Palette is called Tacit Interaction. It is about engaging "*a wider range of human perception and it should enable a larger degree of low-intentional interaction than is found in current interfaces" (Nelson et. al., 1999 p. 7).* The computer is there because it is good at sorting, fetching and showing, not because it suddenly has been good at making a presentation. In the ideal case the lecturer, for example, does not need to know about what the computer is doing—because it is just doing it. All he or she needs to care about is to make an interesting presentation, a task that may be hard enough without an obtrusive technology that interferes with the activity. By the tagging of the printed cards the data inside the computer is becoming tangible and able to manipulate in the physical world.

The Product

When using a presentation program like Microsoft Power Point today the presentation is made 'inside' the computer. The pictures are altered, text is added and then the pictures can be sorted in the picture-sorting tool. It is possible to add pictures from other presentations and thereby making a new presentation that is a mix between the new and the old. The presentation slide-show can be controlled by mouse-clicks or by a predetermined animation or by both techniques.

The Paper Palette is a system that consists of a barcode reader and software. The idea behind the Paper Palette in its current form is to make it possible for the presenter to control his computer based presentation slides using paper cards.

By running a program, called the Paper Palette converter, all pictures inside the presentation file are stored as separate files. The slides are provided with a barcode that represents the filename when printed. The presenter can when wanting to show a slide for the audience, take the paper-card and hold it in front of the barcode-reader. The related slide is then fetched by the computer and showed at the screen. The paper card makes it possible for the presenter to choose, 'outside' the computer, which order to show the slides in during the presentation. They are also giving the presenter an overview and control since he or she in advance can see what is on the next slide.

Why paper?

"The strategy of using physical objects for human-computer interaction (HCI) allows the presenter to work with electronic media and retain affordances lost by moving to a graphical user interface." (Nelson et al, 1999 p.2)

Paper is tangible, is common and it is easy to move around and to produce. On a piece of paper one can easily write or draw something to make a mark or to couple things together. Mark Weiser and John Seely Brown at Xerox Parc writes about calm technology:

"What matters is not the technology itself, but its relationship to us" (Weiser and Brown, 1996 p.1)

Using paper to control a computer program is one way of getting the computational power into the real world. We live in a real world, why work through screen interfaces? The relationship to the digital technology will, by using pieces of paper for interaction, from our view be calmer.

By using paper, or other physical material, you can manipulate physical things that are coupled to digital bits, by tags. Through this manipulation you can get hold of the properties that are connected to paper as well as the ones that are good when using computers. You can dress up the environment with paper and thereby attach information to the object the information is about or related to. In this way you still have an overview and use all your senses as input when performing a task. You do not have to get all the information about all the objects at the same time, but since you know where to look for the information you can easily focus on the specific object of interest when needed. Besides the information is always visible where it is placed.

Using paper as input media you will achieve more than just using the usual input devices such as keyboard. The paper can be used both to put in data to the computer, and to make notes on. Writing a text in a word processor works, but it is difficult to get an overview of the document. This overview is quite easy to get if having it on papers. The relation to the technology is changed if papers are used. It is easier to mark changes on paper than it is in the document. By combining the use of paper, computational power and humans it is possible to create solutions that mixes the best of each to an entirety that is powerful.

The future of computing

On the following pages we will try to sharpen our definitions of what we see as computers in the future. We will try to give a background to our interest in the tangible approach to data manipulation. The aim is also to make a connection between our specific design project and the design theories and paradigms that we are writing about.

Ubiquitous, tangible, calm and tacit

In a course in Human-Computer Interaction (HCI) we were told about clothes that 'knows' everything about itself, the

sweeping machine that can be tracked by position and the computers that are inside the coffee maker to make sure fresh coffee is brewed when the first visitors enters the office in the morning. Since then thoughts about the ideas has permeated our work of the development of computer technology. Bringing the computers out into the world seems, at least in some cases, to be a better solution than picturing the world on a computer screen in the concept of a personal computer. Thinking about computer capacity seamlessly intertwined with the environment forces us as designer to try and broaden our perspective of possible solutions.

Mark Weiser writes about three different sizes of computers: pads, tabs and boards used for different environments. Further he writes that computers such as laptops cannot

"[…] truly make computing an integrate, invisible part of the way people live their life. Therefore we [he and his collegues at PARC] are conceive a new way of thinking about computers in the world, one that takes into account the natural human environment and allows the computers themselves to vanish into the background." (Weiser, 1991 p. 1).

Ishii and Ullmer write about a seamless interface between the physical world and the digital information.

"Tangible Bits allows users to grasp and manipulate bits in the center of user's attention by coupling the bits by everyday physical objects and architectural surfaces. […] The goal of Tangible Bits is to bridge the gaps between both cyberspace and the physical environment, as well as the foreground and background of human activities." (Ishii & Ullmer, 1997 p.).

In calm technology the periphery is taken into account in the development of computer support (Weiser & Brown, 1996). Background, foreground, center and periphery are central terms in the areas of calm technology, tacit interaction, ubiquitous computing and tangible bits. The terms are describing things to think about when designing for an environment that takes benefit from all the computers. What is the center of our attention one second may be the periphery the next, as designers we have to understand and consider this. Placing a personal computer on a table makes it to be in the center. When writing a letter or an article on it the physical properties of the computer fades in to the background. That is as long as the computer works in accordance with the user expectations. We are surrounded by sounds and movements and are *attuned* to them (Weiser & Brown, 1996). The activities are not done in any isolation from the surrounding environment, but are an integrated part of it.

One way of getting our attention, notify us, is when the computer inform us with a beep and a pop up dialog box: 'You got mail'. 'Good', the user thinks and stops doing whatever he or she is doing to check the latest messages. Another example is when you are sitting at the desk having the mail drop, in the hall. Suddenly the well-known bump sound when today's mail arrives on the door carpet marked 'Welcome' reaches the ears. 'Ahh, the mail arrived'. Both solutions are common today.

When connected to the Internet the electronic mail messages are arriving whenever it is sent and sometimes that annoys the user. Sometimes it is obtrusive, sometimes not, it depends on the situation. We are always connected to the postal delivery system—we are aware that our mail will, hopefully, reach us via the mailman every day at a certain time of the day.

Due to our own experience it is sometimes hard notifying what happens, other times easy. Sometimes a small, subtle, change will get our attention. Sometimes can, for example, a beep that under some circumstances would get our attention pass us by without getting any notice.

Car and attention

When driving a car the driver has to focus on different things at different times, depending on the surrounding traffic. The driver has to see things that can disturb his or hers own driving, and react on it. Sometimes things as cellular phones, and car radios can get more attention than the surrounding traffic, which may lead to difficulties. In for example Denmark it is forbidden to speak in a hand held cellular phone when driving.

Due to our own experience of talking in a cellular phone it is not just holding the telephone in the hand that is difficult when driving. The example was when one of the authors of this thesis, Mårten, drove a car on a low-trafficked road and used his cellular phone to call his brother. His attention was soon moved from the road to find the right button to press. Suddenly he found himself talking about the plans of tomorrow and the night. But the car was still moving and he managed to continue driving, at least until he decided to try to make a stop at the roadside. Then when the phone call was over Mårten realized that he not had been fully aware of the traffic situation, that he had lost the picture, and had to create an overview of the traffic situation again.

The focus of attention is not always the road and its surroundings. The attention could be given the cellular phone, the passenger in the front passenger seat, the very complex radio system or the car navigation system. Sometimes the car is asking for the driver's attention by starting to blink with a warning lamp. The changing situations in the environment are telling us as drivers what to do and what action to take. Unless something bad is close to happen, it seems to us the action is taken without any specific notice. It can be argued that someone manages to handle the conversation in a cellular phone better than others do and we would not argue against that, on the contrary. How well the upcoming situations are handled probably depends on how much experience the driver has of using the cellular device and how familiar he or she is with driving. How disturbing a call may be is different from person to person and even from situation to situation.

Car Navigation

A traffic situation may be complex. There is much attention to be given to for example pedestrians, other cars and traffic signals, where we are and where we want to go. As a tool in

such situations one may mention the different kinds of navigation systems that are commonly available in different types of cars. On the one hand we have the system used in, among others, ambulances. When there is an alarm the operator in the alarm central takes a look at a map on the computer screen and sees where the closest ambulance is at the moment. A GPS sender placed at the ambulance makes this possible. The operator then is able to guide the ambulance to the right address (SOS Alarm[2]). On the other hand we have the system based on digital maps placed in the cars. In those systems the driver is typing in where to go and will then be guided to the goal by a voice and by a map on a small computer display. Based on road maps and connected to the GPS they are able to tell the driver (and everybody else in the vehicle) where they are and where to go. To point out the difference between the two types of systems, we attribute them positioning systems and navigation systems (CARiN, 1999).

In car navigation system that we have studied the computer can not sense how much information the driver needs in different situations. When in guiding mode the system gives the same hints, instructions, all the time. Because the driver sometimes knows the way, the guiding function can be unnecessary and annoying when it tells the way anyway. Especially since the navigation systems sometimes are difficult to turn off.

[2] Telephone conversation with Peter Berglund at SOS Alarm in Växjö, 22 February 1999

Music Listening

When choosing a music album from the compact disc (CD) album collection you take the preferred album from the shelf. Perhaps you take a quick look at the cover and make sure you have taken the right compact disc, the one in your hand should match your at the moment music-wishes. You open the cover. In the opened box you see a colored shining compact disc. You press the button-like middle of the cover. Having the compact disc in your hand you are approaching the highly advanced, easy to use, super duper stereo machine. A quick touch at the eject button and the slide is coming out. You carefully place the compact disc at the slide and presses Play. You hear the familiar sound of the compact disc starting to rotate inside the compact disc player. After some parts of a second the first tone of the song 'Thank you for the music' reaches your ears.

When a CD is not played it is still visible for the human eye. If you are searching for an album to play on your stereo you will find it if it is where it is supposed to be. Because the more or less unique cover the eyes will recognize the pattern, the color or the material and relate it to the album. Scratches at the CD-cover may tell you about how old the CD is. Nowadays most of the CDs has one side that are colored, or printed on, and one side that is clean from all sorts of 'at a glance for the eye visible sorts of marks of recognition'.

Looking more carefully the silver side has small tracks that are used by the laser beam to read the data. When played the bits are interpreted making the beats at the CD filling the room.

Unlike the CD the MP3-files (Moving Picture Experts Group (MPEG) Layer 3, MP3) on the hard disk are not visible for the human eye. Unlike the MP3-files the CD are represented in the physical room, outside the computer or the player, when not played. The CDs may be placed in ways that makes it easier to find a certain album. The CD is just a storage medium, and although it is possible to store MP3-files on CD-ROMs it is not very common today.

The order can be rigid, or flexible. When one or the other is preferred depends on the situation. In the CD-case the order can be described as flexible because although someone has been thinking of the order the songs are stored, you as music lover, listener may choose another order. You have the same possibility when listening to media stored on a magnetic cassette (MC) but it takes longer time. Our experience of the media stored at an MC is that it is not as easy to fetch as the data on a compact disc. At the MC the order are rigid. There are workarounds to the problem of storing such, as searching for silent parts of the tape, but it seems to be easier to change the order at a CD than at an MC. MC is as an analog storage medium, the CD are digital but closed–you are able to manipulate the order not change it. That may be depending on that the CD is designed to have a flexible play order. The MC has other properties that are valuable. Yet another digital media is the Mini Disc (MD). The media-type differs from the CD because it is easy to change the physical storage order, not just the play list.

When talking about MP3 files there are no 'natural' nor designed order of storage. The files are stored, as files usually are stored in a computer. How the files are stored internally should not be interesting for the computer user unless of course the order affects the performance. The operating system makes it possible to find and operate files in a way that makes sense to the computer user. When having the files unordered from the beginning the user still wants to listen to the songs in a certain order. With the MP3-players available today (for example the Winamp[3]) you have the possibility to add one or many titles into a playing list. It is also possible to add a folder consisting of for example an album with related files. The files are played in the order they are added. It is also possible to play a certain file just by choosing it in the menu. The list can be printed as an HTML-document. The list of songs can be used as an artifact when listening to music in a similar way as the CD-box cover.

Two ideas

From the examples above, car navigation and music listening, we have got two design ideas, which are based on the Paper

[3] Nullsoft inc. copyright 1998

Palette concept. The idea dealing with car navigation we have called NaviMap and the other, dealing with music listening, TitleTag.

TitleTag

We think that the future storage of music will be handled directly on the stereo equipment. MP3 is a step in this direction, and it seems to be developing fast. Experiments are going on (in the USA) where the users legally can download the music file they want from the music company's homepages and then pay, instead of buying a CD at the music store. Everything is done from their personal computer. But do you want to go to your computer and start your player to listen to music? Our idea is to print a list, from your computer, containing your music files, sorted in the order you want them, and then use a scanner-pen to choose what song or artist you wants to listen to.

Our aim was to interview and film how people are playing and choosing music today. We have done some initial research on this but we found it problematic to continue. Further investigations on this would require that we went in to somebody's' homes, something that both we and those we have spoken to felt uncomfortable with. At this point in the project we had a lot to do with our other project idea, the NaviMap, and we therefore decided to use the TitleTag as a generative metaphor and something to compare NaviMap with. The empirical material presented in this report will therefor only be from studies for the NaviMap.

NaviMap

Our experience with car navigation is that you have to spend quite a lot of time and attention to the navigation system while programming your final destination. One of us also has a real life experience from such a navigation system in a BMW 750iL (see appendix B). We then thought—perhaps tagging technology can be used for this. If every street in the register was represented with a barcode, a barcode reader attached to the car navigation system could be used for programming the address. The same method could also be used in the yellow pages in the telephone catalogue, and on information boards at tourist information places. The idea was further developed when choosing to design the system for a group of professionals that we thought needed the support given by navigation systems—truck drivers. We had a feeling that they often had difficulties finding the right place, and that it took valuable time from the workday. At the same time we thought that if they were interested in a system they wanted it to be easy to operate. Navigation systems for truck drivers also could involve different areas of problem than designing for passenger cars. Trucks are neither allowed nor able to drive everywhere, and designing a navigation system should give us a possibility to decide what is important to support.

Preparing for the next chapter

With these ideas and concepts in our knapsack we went out on the field to do empirical observations.

Empirical

Since the idea behind NaviMap is car navigation, our focus has preliminary been on how the truck drivers find the right address[4]. This chapter is about our main findings from our field studies at the haulage contractor Karlshamns Expressbyrå, from our four days of truck travelling and the half-day with a traffic leader.

The names has been changed

To avoid identification with the real drivers or traffic leaders we have chosen to give them pseudonyms. Let us present the drivers and the traffic leader that occurs in this report:

Joey is, in relation to the others, a young driver. He has been driving for the company in about three years.

Henry is a man with more than thirty years of experience from truck driving.

Perry has around twenty-five years of truck driving experience.

Ernie—the traffic leader—used to drive trucks himself before he started his work as a traffic leader.

A truck driver's workday

This part is an example of what a truck driver's workday can look like. From our four days travelling with different trucks, we have taken different sequences and put them together to a story. The text is written to give the reader a background to the field that we have been studying. We begin with telling the story and thereafter we discuss what we have seen.

The morning starts early with a brief meeting at the haulage contractor with the traffic leader. The driver gets the folder with the waybills for the truck he is going to drive. Quietly the chauffeur looks through the waybills. Some of the cargo may already be loaded on the truck and some may be in the storage space, waiting to be loaded by the driver. Questions can arise for example about delivery-addresses they see in the waybills, if it is possible to bring the trailer or what different cargo details means.

After the brief meeting, they load what has to be loaded from the storage central, and when they are sure that everything is

[4] This part of our report includes many quotes from transcribed parts of our field material. In this cases we will write the translated speech first followed by the original Swedish speech. The authors have done all the translations.

Transcriptions of two parts of our field material that is referenced in this chapter is presented in appendix C and D.

ready, they take off. At this time they still do not know how many loading-orders that they will get during the day. When loading, consideration is taken to frozen cargo. If both frozen and non-frozen cargo is to be loaded, the frozen has to be in the front of the platform, separated with an isolating wall. This because of the refrigerating machine is in the front of the platform, above the cabin of the truck. We have seen two ways of dealing with this. In the first case all the non-frozen cargo were delivered first, and then the frozen. Everything was unloaded from the back by the driver and his pallet lift. In the second case the side door was open and the cargo was unloaded with a forklift from the side of the truck. In which order the route is driven can by this be said to depend on what possibilities there are to unload the cargo without damaging the frozen parts of it.

Another thing that has to be taken into consideration when driving is the trailer. When having the trailer behind, we have noticed that they do not want to drive on narrow roads, and especially not coming to dead ends. An important thing for them to know is if it is possible to turn around with the trailer or if it is better to catch it off. If a colleague has been at the place before, he can serve with important information otherwise it is up to the chauffeur to make a decision. The choice stands between taking a chance and hope it is possible to bring the trailer, or drive several of kilometers extra, park the trailer, and have a sure delivery/load without risking to get stuck with the trailer. To decide that the trailer has to be catched off also demands extra planning of where and when to do this.

Around noon most of the deliveries have been done, and loading orders comes from the traffic leader. This can be done either by the cellular telephone or via the Mobitex. The Mobitex is a small terminal in the truck, on which the drivers can see the incoming loadings for the day[5]. Only two trucks, on the firm we have visited, have Mobitex so far, so most of the orders are handed over to the driver by telephone. The drivers we have seen write the orders down on a piece of paper. Then they start to plan for the new orders, and tries to combine this with the cargo that still has not been delivered. This is an ongoing process for the rest of the trip. Planning and re-planning to get the work to go as smooth as possible. This was something we saw extra clearly when travelling at the Malmö-line.

The Malmö-line is the route going to an area in the southern part of the county 'Skåne'. Malmö is the central goal on this route and thereby the drivers call it the 'Malmö-line'. Often there is a lot to do on this route and it is therefor not unusual that two trucks are driving here at the same time. This was the

[5] There are different kinds of Mobitex systems today. The one we have seen works as a mobile data terminal. The pick-up order is on the traffic leader’s command transferred from his computer to the in-truck Mobitex Terminal making it possible for the driver to read the incoming pick-up orders. When he has seen them, he confirms that he accepts to pick it up, and this is shown on the traffic leader’s computer. Also when picked up he sends that information to the system so that the traffic leader may see that the cargo is picked. The haulage contractor we visited tested the system in two different trucks.

case at one of our traveling days. The deliveries were already settled and taken care of by the drivers alone. When the loadings then were coming from the traffic leader, they were only given to one of the drivers. The only thing the traffic leader cares about is that he has two trucks on the 'Malmö-line'. It is up to the chauffeurs to cooperate to make the work to go smoothly. The driver who gets the loading information then calls the other and the following scene was taking part;

At lunchtime the other driver calls Henry. He has a long list on loadings from the traffic leader. Henry finds an empty paper, the line-list (a summary list of the deliveries), in the cabin on which he write important information about the loadings. This information is the name of the customer and how many pallets and their weight.

When Henry has the information, he sees that he can combine one of his remaining deliveries with one of the loadings. The colleague agrees and they finish the telephone call. Since Henry knows that the customer can be hard to reach, he calls him up to check that there will be someone at the customers loading central to help with the load. We then drive towards Trelleborg. During the drive Henry several times takes up the handwritten loading-list and looks at it. Suddenly he calls the colleague again, to check his status. They discuss the different places, where they are now, how much there is left to be loaded, if there are any time limits at the loading place, where the cargo shall be delivered, who shall go to what place according to cargo and delivery places, and so on. After a long planning-discussion over the phone they have made a plan and an agreement about who is going where.

If everything goes without extraordinary complications, the drivers return to the haulage contractor, 'home', in Karlshamn late in the afternoon. There they continue working in the storage space with the incoming and outgoing cargo. As far as possible the cargo for the next day is prepared.

Comments on the truck driver's workday

In the morning we could see how the drivers used the waybills to, as we see it, *frame the situation* (Schön, 1991 p. 40). They used the waybill to plan the route and also load the cargo on the truck in a way that supported this plan. We will discuss this further in the part where we write about waybills.

When Henry wrote down the information about the different loadings, he did not have to write the addresses down, only the names of the customers. He was familiar with the addresses by their names.

At the same time as Henry plans his own route, he is aware of the route of his colleague and what deliveries he has. The route seems to be growing gradually in his mind, and when he has loaded and is about to leave Trelleborg he calls his colleague for a final discussion. It is like a 1000 piece puzzle to be laid. We could see that he wanted the route to flow as smooth as possible. Deliveries, pallets, weight and customers closing time. Everything has to be taken into account to reach

the optimal flow (Norman, 1993 p. 31 ff), and after this final telephone call, everything seems to be coordinated and due to our observation everything goes fine. An example that we find is showing that Henry is aware about his colleagues' loading is that he also planned for the coming workdays' deliveries. During the telephone conversation he says to his colleague to take another loading on his trailer too, because then all deliveries to the Karlskrona-area tomorrow are ready on his trailer and has not to be re-loaded at home.

After this overview on a truck driver's workday, we will now dig deeper into our main focus—the way they find the delivery and pick-up places.

How they find the right way today

We have noticed how the truck drivers make up a plan for the trip when looking through the waybills. If the delivery address is in an area that they do not have a clear experience from, they ask their colleagues. We will discuss this area of interest from some examples of finding the right way that we have seen during our field-studies.

Addresses

We have noticed particularly one driver, Henry, who has been at the most places that can appear in his work. If someone wonders about an address, they usually ask Henry, and he can give an exact answer in approximately nine times of ten. We have had the opportunity to follow Henry during two days of the four we have been out. Even if he says that he does not always have a totally clear picture of the location, he finds the right way somehow. It seems, to us, like he has a kind of 6th sense, which makes him come to the right place. His long experience makes it possible, if he know what sort of company it is, to see on an area where the company may be. He also told us that if the city architect in the city was 'a clever kind of fellow', his 'logic planning' of the town could help finding the right place. For example if the address on the waybill said 'Ekvägen 14' (Oak road) and the driver last time had been at the 'Björkvägen 11' (Birch road) in the same city, the logic could make him figure out the 'Ekvägen' should be in the same area—the area of tree roads.

Henry said he felt that it was difficult finding the way to the right address when there were two or more roads in the neighborhood named similarly, for example 'Ekvägen' or 'Ekgatan' (Oak street). Other times when it is difficult is further out in the country, to a distant delivery place in the middle of nowhere.

When we was observing Perry he got an address to a place he had never been before, a print shop. When we approached the city in which the address were he said that he predicted in which area the road was because he knew there was an area where all the streets have names that are related to aircraft and airports. The reason for the naming of the street names could have something to do with that the industrial area was placed upon the city's old shut downed airport. When talking about it in the cabin Perry said that he was not aware about that it was

an old airport, but the name of the surrounding streets indicated where it should be. To have domain knowledge about a place and its history seems to help in the process of finding the right addresses.

Cooperation

A little now and then the colleagues call Henry up to ask for road description. One example from our field study is when we are approaching Tomelilla in Skåne. The other truck, also driving in Skåne—the Malmö-line—this day, is on its way to Dalby and the driver wonders what road to take. Henry immediately starts to describe the best road from his mind. But it shows that the other driver already has passed the actual crossing. Henry then has to adjust his understanding of where the other truck is, and then he goes on from there.

Afterwards Henry explains that the newer drivers often only drive the newer bigger roads, and of course they can drive a little bit faster, but it also gets longer. Henry prefers the elder, smaller, closer 'country roads'. We think that therefor it is sometimes hard for the other driver exactly to understand the road Henry explains.

The Sjuhalla Example

Morning has risen at the haulage contractor's garage

The case described below took place a day in February when we were following Joey and his truck around the county of Blekinge. In the early morning back at the storage central we met the truck driver and the traffic leader. They had a short conversation about the day—the equipage should be unloaded in a nearby town. The cargo consisted of everyday commodities, bound for two different stores, and two windows that was to be unloaded at a construction site.

Joey and Ernie talked about the freight and, because Joey had never been in the area where the construction site was settled, they discussed how to find it. Henry, who also was in the office, knew where to find the site and explained it to them. Joey took the documents of the cargo and prepared leaving the haulage contractor.

On our way to the construction site

After unloading the everyday commodities at the stores we left the city. Joey knew which place to start the seeking for the construction site from. After about ten to fifteen minutes we left the motorway and turned left. After a while he said he saw a sign marked 'Sjuhalla' and turned left, saw another sign and turned right. During those actions he was consulting the waybill to see what the address was. He said:

9.15.10	"What does it stand there…? Huvsroad"	*"vad står det där…? Huvsvägen"*
9.15.13	"H-U-V-S-road"	*"H-U-V-S-vägen"*

While driving Joey all the time looked around a lot in the surroundings. He had some information about where to go—'Lövsjöhus byggarbetsplats' (byggarbetsplats = construction

site) in a place called Sjuhalla. He said he needed a forklift to be able to unload and mentioned the advantages having a telephone number to be able to announce his approach and avoid the waiting time.

9.18.04	"Working site, you should be able to see that. I think it can be a such a nice villa towards the sea that perhaps is over here. Because it was of course no small windows. Not such a like cheepness windows, that I do not think. Quite exclusive stuff."	*"Arbetsplats, det borde man väl se. Jag tror att det kan vara en nån sån där jättefin villa utmot havet som kanske ligger här borta. För det var ju liksom inga småfönster. Det var inga sådana där billighetsfönster, tror jag inte heller. Rätt så exklusiva grejor."*

The environment we drove through can be described as a summer cottage village consisting of different kind of houses. The driver looked out through the cabin windows and searched for something looking as a construction site. He saw sites but clarified that the windows in the cargo should not fit in the houses being built:

9.20.26	"[/Mårten/ There is a construction site, if you…]"	*"[/Mårten/ Där är en byggplats, om du…]"*
9.20.33	"It should surprise me if that should be the case. No, it is not the right windows."	*"Det skulle i och för sig förvåna mig om det skulle vara så. Nej, det är inte dom rutorna."*
9.20.40	"There! (mumble) That is probably a quite newly built house as well. The windows are too large (laughs)"	*"Där! (mummel) Det är nog rätt så nybyggt det huset också. Rutorna är för stora (skrattar)"*

Joey said he wanted to ask someone after the road description but when no one where available to ask he continued the driving commenting that it was fun with a sightseeing after all.

After a while, driving very slowly to search after the construction site, there was a sign of a road construction. Joey said:

9.22.07	"Road construction work! Aa, but look here this look very good, look… Sjuhalla, Sjuhalla bridge."	*"Vägarbete! Aa, men titta här det ser ju jädra bra ut, kolla… Sjuhalla, Sjuhalla brygga"*

He accelerated and came to a place where the road divided in one to the left and another to the right. He loudly read the road name and looked at the waybill he had held in his hand since the last delivery, then he read the road name again:

9.22.19	"And there it stands… Not our… Here it stands Huvsvägen. [/Mårten/ Havsvägen [sea road]] So it could be. Havsvägen (Sea road), lets go for that, it sounds good, it sounds more realistic, Havsvägen than Huvsvägen."	*"Och där står… Inte vår… Det står här Huvsvägen. [/Mårten/ Havsvägen./]. Det kan det vara. Havsvägen, det kör vi på, det låter bra, det låter mer realistiskt, Havsvägen än Huvsvägen"*

The name on the waybill and at the road sign was not the same. Joey decided to turn left on the road. After about fifty meters there were a construction site on the right hand.

9.22.38	"There is the construction site. Thank you for that Telephone Company[6]"	*"Där är bygget. Tack för det Televerket."*

Joey stopped the truck and commented that it had to be there because the windows seemed to fit into the house. In the same sentence he said that he needed a forklift to unload the truck.

9.22.50	"And here we can just forget… There the big window, that I have, will be. Here we can just forget to be able to unload it. We have to go out and talk with…"	"Och här kan vi bara glömma… Där skall den stora rutan, jag har, vara. Här kan vi bara glömma att vi kan lossa den. Vi får gå ut och prata med…"

He killed the engine and left the truck to seek after some construction workers to notice them of his arrival. He walked around the house and commented it. He found the workers in a small house in connection to the new built one. The construction workers rang for the forklift and we were advised by the construction workers to park in the way crossing a little bit from the site to be able to unload the truck in a smooth way.

[6] This expression 'Thank you for that Telephone Company (Tack för det Televerket) has been frequently used in an advertisement for the Swedish Telephone Company.

Comments on the Sjuhalla Example

When analyzing the recorded sequence we noticed that the driver seemed to shift focus between driving, searching for the address and looking for a previously lost waybill. Probably he was conscious about everything all the time, but his focus of attention seemed to shift from the missing waybill, to where to go, to seek for the construction site and then back to driving the truck. He holds the new waybill in his hand during the whole sequence, looking at it regularly and sometimes reading aloud and spells the name of the address. Looking at our video recordings the waybill seems to be a central artifact for the driver when to find the construction site.

At the same time he looked at the houses passed and matched how the windows in the cargo looked with the size and appearance off the houses (Dv[7] 1 at index 9.18.04). This awareness of the cargo we presume was a result of his participation in the loading the day before—he knew about the windows and had created a picture of in which type of house they would fit.

When he saw the construction site with a semi-ready house he knew that it was the right address. He established that the windows he had in the cargo should fit in the house (Dv 1at index 9.22.50). It seems like he used the shape and the properties of the windows to navigate to the right address.

[7] Dv = digital video tape

Finding a Print Shop

The Central Print Shop in Ystad

The day we observed Perry he had to go to a few new places. The airport related, as mentioned above and a print shop in Ystad. At the latter place he should deliver a load of paper. This example starts a few kilometers outside Ystad after delivering a cargo on some other places at the country.

Perry stopped at a picnic area and killed the engine. At the picnic area there is a large information board displaying a map over the city. He looked for the name Stallgatan (Stable street), at the big map. Since Ystad has an old, closed down, cavalry regiment, Perry was seeking for the street in that area. But when he did not find the street name he decided to take a coffee break. He also took a map from an information box. When he had finished his coffee, he took a closer look at the map and said that it was no good. He folded the map and put it in his pocket, opened the door and returned to the information board. On the information board there were three maps: One overview of the whole municipality, one overview of the city and one detailed of the central parts of the city. This caused Perry a lot of trouble since he found the street name in the index but not on the medium detail level map. After a while he found the detailed map and the Stallgatan. The street is in the central part of Ystad. When he now knew where to find the street, he wondered where we were (DV1 at index 22.39) and tried to look up the place at the overview map.

When driving away from the picnic area Mårten asked if he found the address and Perry answered:

26.14	"Yes, but I can't be wise on how I shall get there. Hehe…"	*" Jo men jag blir inte klok på hur jag ska komma dit. Hää"*

Perry drove towards Ystad and turned right at a traffic signal. When driving on a street called Regementsgatan (Regiment street) he looked left. After a while he said something about that 'it will be alright' and drove to an industrial estate outside Ystad where he parked the trailer. He drove back towards the city with the truck and turned in to a smaller street when he said:

37.20	"Ystad Print shop. We drive somewhere and then we can see where we ends up"	*"Ystad Tryckeri. Kör någonstans så får vi se var vi hamnar"*

He continued driving for a while, said that it was meaningless to wander around, and then started to look for someone to ask. He stopped the truck in front of a kiosk, took the waybill and was on his way to climb out of the cabin when he looked through the windscreen, saw a delivery firm and said that he was to take it instead. He walked around seeking for someone to ask, and then found a man that told him where to drive. Perry told the description given when returning to the cabin:

41.50	"/Mårten/ How did it go? /Perry/ We are going to go there, you know, to the public bath, then we shall go to the right. It is only narrow streets in here."	*"Mårten: Hur gick det? Perry: Vi ska ner där, vet du, vi badhuset, sen ska vi till höger. Det finns bara små gator här inne."*

Perry started the truck. Because we are looking about how he finds the right address we will give an account of what he said when following the description:

42.19	"Public bath, public bath"	*"Badhus, badhus"*
42.27	"Where the h-ll is the public bath (mumbles)"	*"Va f-n är badhuset (mumlar)"*
42.37	"Here I am in the middle of the square, I remember that we should come here."	*"Här är jag mitt på torget, hit kommer jag ihåg att vi skulle."*
42.55	"But any public bath (inaudible [on tape]… I can not see)"	*"Men något badhus (ohörbart [på bandet]… ser jag inte)."*

43.05	"Now we are down here"	*"Nu är vi ju för f-n här nere ju."*
43.14	"I can not see any public bath."	*"Jag ser inget badhus."*
43.25	"Have you seen any public bath? Here is the public bath! Yes, but then we are down here. Then he could have said the whole way down to Östergatan (East street)"	*"Har du sett något badhus? Här är badhuset ju! Ja men då är vi ju här nere. Då hade han ju kunnat sagt ända ner till Östergatan."*
43.45	"Yes, exactly, there is the ferry berth, there at that side."	*"För just det – där är färjeläget, där på den sidan."*

When coming out on Östergatan (East street) he found the first street to the right. Then he stopped and loudly asked himself where to go. After a minute he decided to continue and stop further on at the street-side. He started to talk with a man on a bicycle:

45.20	"Stallgatan, Central Tryckeriet? /Man at bicycle/ Yes it is up there, where you held—you should have continued straightforward. /Perry/ Is it a street in there? … /Man at bicycle/ Yes, there is the Central Printer. You probably have to back in… (inaudiable)"	*Stallgatan, Central Tryckeriet?* Man på cykel: *Ja det ligger här uppe, där du höll – du skulle ha kört rakt fram.* Perry*: È de en gata där inne. …* Man på cykel*: Ja, där ligger Central Tryckeriet. Du får nog backa in – (ohörbart).*

When returning to the cabin Perry said that the man at the bicycle thought that he had to back in. Later, after a few moments, the man told him what he had observed before, that they used to do the unloading at the street and that they were getting it with a forklift. Perry decided to turn around the truck and back it in on the street, but before that he walked to the print shop and talked with the personnel there about what to do.

Comments on the Ystad example

We find this to be an interesting example of how a truck driver finds his way to the right address because it shows many different ways of getting the right information and that not all information is useful. Or at least not so useful that the truck driver should have wished. Since the man at the delivery firm had told Perry to drive down to the public bath, Perry looked for it. But he could not find it until he was at Östergatan. In the crossroad he saw the ferry berth, and

commented that the man could have told him to drive down there instead, because he would have managed to find it. Later on Perry said that he tried to find delivery firms to ask because they often could give good explanation on how to get to a place. This could be seen as a matter of talking different languages. You can describe where something is and how to get there, but if you are not a truck driver you may not be aware of obstacles for the truck. You may as well have different point of references.

The example also shows that the driver uses the information boards in a way that you can expect. The reason for staying was both to take a break and to check up where the Central Print Shop was located in the town. In the transcription he says that he would like to have the street to the old regiment (at index 21.40). This might have been his assumption since the logic of a town, as we have written before, often is coupled to its old history. That the street probably was in the middle of the town center gave him hints about that he had to detach the trailer before continue his search. He knew that there were only narrow streets inside the city, because he had been there before. He also told that a print shop inside the central part of the town did not make sense at all, because he could not think of any reason to place a print shop there.

On another occasion, when we showed our NaviMap design, we talked with both Perry and Henry. Perry mentioned the print shop in Ystad as an example of how to find the right way and Henry directly knew where it was. He also told about how to get there, something like 'just go over the square and then hope that you can get in on the street'. Perhaps that is what Perry will do next time he is to visit the Central Print Shop in Ystad.

We have now described some examples of how they find the way, and what we have seen is that the waybill is very important. What is then a waybill and how is it used?

Waybills—important pieces of paper

When starting to look on truck drivers' navigation we presumed waybills to be important artifacts for the driver. After the first day on the field we came to the conclusion that the waybills seemed to be central artifacts in the daily work of the truck drivers we studied. Later on we decided to include the waybill in the design of the NaviMap navigation support system. On the basis of some examples from the empiric studies we will describe what we have found regarding truck drivers' and traffic leader's use of waybills.

At pick-up points

The shipper issues a waybill every time cargo shall be shipped. When the truck driver arrives with his truck to the pick up point he makes sure to get the waybill. Each waybill consists of a few sheets of paper. The customer signs one of the sheets and leaves the remaining packet to the driver. The shipping customer keeps the first sheet when a truck picks up the cargo. The rest of the document is following the cargo until it has reached its final destination.

At the Haulage Contractor

Karlshams Expressbyrå has a home location where they re-load cargo. For example cargo that are picked up in Malmö, in southern Sweden, can be loaded on a smaller distribution car or a long-distance truck bound for Europe or Umeå in the northern part of Sweden. When the driver comes home he hands the waybill over to the traffic leader. The traffic leader plans what truck and trailer that shall carry which load and are also putting in data from the waybill into the traffic leading system. The waybill also serves as a resource for not putting a too high amount of load on a single equipage.

Waybills that are returned from the field when the cargo are delivered are saved in large bunches with around 80-100 waybills in each. The reason for saving the waybills is that the customers can claim that the load is damaged or that the cargo that should be frozen was not cold enough during the whole transport. Another reason is that they serve as basis for invoices. After some time the waybills are archived and registered in a database, by the office administration.

Before leaving the base-location for the day or night the drivers are visiting the traffic-planning office and gets their new waybills in a folder. Often the drivers glancing through the waybills in the folder before leaving the office and ask the traffic leader if there are any thing they would like to clarify. Things to clarify can be about where a certain place is or where to find the specific cargo in the loading area. Sometimes the cargo is loaded the night before and sometimes the driver has to load it by himself before leaving. Here

Picture 1 Example of a waybill

follows three examples of loading from the home location, the haulage contractor.

Loading for another driver

Joey loaded the truck for his partner driver; they were two drivers that alternated to drive that truck, when he was ready for with the delivery and pick-up. He got instructions from the traffic leader about what cargo to load. When loading the trailer he took care about which order the delivery addresses were in and commented it with:

14.50	"You try to do it as easy as possible for the other, because otherwise it is of course… (Inaudible on tape) it is of course ones buddies that drives."	*"Man försöker göra det så lätt som möjligt för den andre, för annars é det ju… (ohörbart på bandet) det är ju dock ens kompisar som kör."*

When the colleague came to the site the driver went through were the different things were placed in the trailer. Earlier in the day, before unloading cargo at a store, Joey talked about the importance of sorting the cargo before leaving 'home'. He said:

8.32	"It is better to spend an extra hour sorting the cargo, because you have it back several times, than it is to just drag it in [talking about the cargo] and go. I know that it has been some guy here that dragged it all in, and then just went away. For sure he was away one hour earlier than everyone else, but he was home many, many hours later than everyone else. So if you spend two hours at home [at the haulage contractor] to sort up the whole load and sort the waybills and all that, so you have it back several times."	*"Bättre lägga en timme extra på att sortera godset för det har man igen hur många gånger som helst än att bara dra in det [syftar på lasten] å åka. Jag vet att det vatt nå'n kille här som drog in allt å så bara iväg. Visst va han iväg en timme tidigare än alla andra, men han var hemma många, många timmar senare än alla andra. Så lägger man två timmar hemma [syftar på åkeriet] på å sortera upp hela lasset å sortera fraktsedlar å allting, så har man det igen hur många gånger som helst."*

As can be seen he talked about 'sort up the whole load and sort the waybills and all that' indicating that both the cargo and waybills are sorted in a way that corresponds to the actual delivery route. The day before Joey had been in Gothenburg and picked up the cargo. When arriving home the night before he, and probably some of his colleagues, had re-loaded—re-

sorted—the cargo. The re-loading is as well a matter of sorting but as it as of getting the cargo to the right delivery place in the right time. The extra hour of work in the night before was used for sleeping a little longer in the morning.

We have some examples of how the waybills are used:

Henry came to the haulage contractor early in the morning. He had been free for some days and the evening before Ernie had called him to give a briefing over the coming workday. Henry explained to us that he had got the understanding that there was a lot to do and he decided to start early in the morning. When he arrived and went out to the truck he started with looking through the waybills. After a while he also compared the waybills with the information on the Mobitex. He said he thought something was wrong, because there was not that many deliveries he had got the understanding there should be. There were only about five waybills, and as far as he had understood there should have been a lot more. He went out of the cabin to look at the cargo on the trailer and the truck. He had to assure himself that all the cargo really was loaded, that the information on the waybills agreed with the cargo loaded on the equipage. After a while he came back into the cabin and looked at the 'line-list' to see if there was any extra information, but no, it contained just the same amount of deliveries as he had got out of the waybills. He then went into the loading area to see that nothing was forgotten. Nothing extra was found. One last time he went out to compare the waybills with the cargo. He left with the comment 'When you have not loaded the cargo by yourself, nothing is right'. The cargo seemed to agree with the waybills and now he really could not do anything more, so he took off.

Another example was when Perry in the morning before leaving home asked for some palettes. He went in to a small room in the storage area where he found some waybills, but not the one he looked for. The reason for this, he told us, was that he would be sure that he had not forgot anything. When the traffic leader, who had just started his shift, came in to the room he told Perry that the palettes he searched for had been shipped the day before, alternatively not yet arrived.

On the road

Perry usually sorted the waybills so that they were in an order equivalent to the one that he planned to visit the different delivery places in.

Joey, when finding the Lövsjöhus construction site, kept the waybill in his hand during the whole matching process. In times and another he read the address aloud from the waybill. He also consulted it to see if there was any telephone number to the site.

At the delivery-points

When arriving at the delivery-points the cargo is unloaded and when everything is ready the driver lets someone at the company inspect the goods. Often this inspection includes checking that the number of palettes delivered corresponds to the one at the waybill. At the same time the driver gets a

chance to show where he has put the palettes. In some cases, when delivering everyday commodities (for example coffee, pasta and sugar) the one responsible inspects that everything is delivered.

Information and added notes on the waybills

We noticed that the placement of the cargo on the equipage was written with pencil at some of the waybills. By our understanding this was written by them who loaded the truck the day before. It was not written on the sheets themselves, but at the top of the paper that kept the sheets together. The information told if the cargo was placed in the front, middle or the back of the truck or the trailer on the right or the left. This information was probably used as a reminder when Perry should unload cargo. Where the cargo is placed and in which order it shall be unloaded affect how to dock with the shops or warehouses or if a forklift is needed for unloading or not.

The waybills have delivery addresses printed in the top of them. Sometimes the addresses are not complete. Joey told us that telephone numbers were very good to have. Often the only address information was the street name and company name. Since the waybills consists of several sheets of paper that are copied with carbon paper and the driver is the second person to have the waybill the text may be difficult to read.

In the Sjuhalla-example the street name seems to have been miss spelled—there is an u when it should be an a. This miss spelling is easy making the road name to be Huvsvägen (that in Swedish does not make much sense) instead of Havsvägen (the Sea-road). Still Joey did look for the Huvsvägen until he found Havsvägen. When we observed Ernie at the office in Karlshamn, Henry called in and asked about something called 'Stera terminal' in Ystad. He called in before he was ready to do the pick-up and in connection to when he checked the incoming orders in the Mobitex-system. Ernie did not know about any 'Stera terminal' in Ystad but decided to look it up. After some consulting in the three-year-old telephone catalog for Ystad he called the traffic leader that wrote in the information into the computer system. He found out that the right name should be 'Stena Terminalen' and to be sure about it he called the customer in Gothenburg. In this case the customer confirmed that it should be 'Stena Terminalen' and also said that the load was to arrive the next workday.

Other information that is on the waybill is about the weight and dimensions of the load. If any load is damaged when delivered that is noted on the waybill and signed by the driver. When transporting frozen products it is very important that the load is in the right temperature, an information that is found on the waybill. If not, the customers can claim to get their money back. If any malfunction happens it is noted on the waybill.

Some thoughts

Even though not everybody is writing where the cargo is stored the waybills may serve as hooks for the memory. If there is someone that knows about how the truck and trailer is

loaded this person can tell and then the driver may use the waybills as an artifact to know where to find the cargo.

At the same time as the drivers seems to be aware of miss-spellings and errors at the waybills they rather check for the wrong name instead of guessing for an alternative. It can be about trusting the information written on the waybill because even though they are standing in front of a company or road with a similar name, the other name may still exist—a few kilometers away.

Central observations

The observations have given us a lot of important insights in the truck driver profession. Especially how much more there is than just finding the right address. Therefor it has been important to us to take all this into account when designing NaviMap.

We have seen how flexible they are when planning the route and making the deliveries fit with the loadings. How the drivers cooperate to get the work done in an optimal way, as well as at the storage central as out on the route. The waybills are very central in the practice. They contain much of the information the driver needs to grip the situation and being able to plan his route. Much of the important information also is in the experience from places visited. When being at a place or knowing somebody else has been there is a great support when planning the route.

The drivers we have met are experts in what they are doing and the longer experience, the greater repertoire of examples they have (Schön 1991, s 138). But no matter how experienced, we have seen that there is always situations that makes them take decisions with outcomes that they in advance are not able to make a clear conception about. If a problem arise, they are solved *ad hoc*.

We have found that the drivers find the right way somehow, for example by using maps, experience, colleagues, delivery-firms, waybills and knowledge of the cargo. The cargo affects how to drive and in which order to visit different delivery places. The drivers talk with each other about places they have been at—if someone does not know, another driver may have been there and has the knowledge.

Design

As we described earlier we have two ideas which we have worked with NaviMap and TitleTag. In this chapter we will present what we did, how, and why we did it. Our main concern is about the NaviMap. But first we will give a small description of our design thoughts of the TitleTag.

The Design of the TitleTag

The idea for the TitleTag came from the use of MP3-files. It is really hard to have an overview of the songs you have stored on your hard disk. We thought that maybe the Paper Palette concept could solve this. Instead of using barcode technology, we did chose to use text and a text-scanner-pen. The reason for this is that barcodes are hard to interpret for humans while text is rather easily understood. The scanner-pen is connected to a computer (or, in a possible future, a stereo device) with infrared transmission and when you scan an artist's name and album the chosen music starts to play. The text is sent to the computer and the music starts playing. Next time you scan an entity it will be put in line and it will be played when the first song ends. The text entities might look like this:

Jackson, Michael; Bad; (the complete album)

Beatles; Yellow submarine; All together now (one song)

J, Lennon; Walls and Bridges; Old dirt road

It would also be possible to scan a command, for example 'Random' and the computer should choose among the songs in the playlist. Playlists should also be possible to create and access by just scanning their given name. The text entities can be printed on ordinary pieces of paper as list or on cardboard cards. The advantage of the latter is that one can use them in a similar way as CD-covers, (leave them on top of the player when played, browsing through them, and so on). The text could also be accompanied with pictures.

Some central parts of the TitleTag are the *scanning pen, paper, printer, computer, a database, a GUI* and *the MP3-files, a program to play the MP3-files with*– that is the technology we deal with as designers. The *user*, in this case is the *music listener*.

The relation between the different parts can briefly be described as follow: a person will use the scanning pen as an artifact to choose the song from the paper. The scanning pen reads the text, translates it with the Optical Character Recognition (OCR) program and sends the code to the computer. In the computer the text is interpreted in a database consisting of MP3-files and the song title is compared with the song titles stored in the MP3-files. Depending on whether the user wants to play the song or just make a compilation, a

playing list, the file starts to play or is just added into the database. The printer is used for printing new lists with songs or index cards with artist names. The computer is central in the same sense as the scanning pen central to the system because it allows the actions to be taken. When choosing a song to play the computer shall act in a similar way as a CD player does today.

NaviMap—in cabin navigation support system

It is the one that drives wrong that finds the new roads

Inspiration of other systems

The NaviMap design is based on what we have seen when observing truck drivers work practice. Our wish was to accomplish a design that made it possible to keep the good properties with a navigation system at the same time as it could be used in the same way as, for example, a revolution counter. The support is available when one needs it and one can ignore it otherwise. Our experience from car navigation systems was that they were disturbing and difficult to handle when driving (see appendix B, appendix E**)**. They did not seem to be designed for use while the car was in motion. The programming session was complex and forced the driver to read and focus on text on a little screen, resulting in a loss of attention to the surroundings.

Before the light

In the beginning, before visiting the field, we had ideas about what the navigation system should support. During a project internal workshop we presented our thoughts about how the system should work and what to deal with. We assumed the information board, at picnic areas, to be a central artifact for the driver when coming to a new town and that the information could be displayed on a head-up display in front of the driver. Another thought was about informing the driver that ambulances approached from the behind and that systems that knew the weight of the truck so that the information boards could show only those streets that was passable for the equipage. The scenarios and ideas made us think about what we wanted to accomplish with the system and how to accomplish it. We did not want a control system that stressed the driver, but a system that supported the driver. If the driver had been in the town before, at the same company and would not like to be guided, he should not be guided. But the system should be there, when needed—ready at hand without warming up time. The information boards was in our thoughts central in a way that they could print out a road description to the driver with a barcode that should be accessible to the in-truck part of the system.

The system should contain and present information about roadwork, queues and other disturbances. It should be possible to get suggestions on what road to choose with the disturbance factors taken into account. The chauffeur should have an option to see where other drivers were, so pauses could be planned and performed at the same place as the colleagues.

The next phase of the design process was to do empirical studies.

Design thoughts and decisions

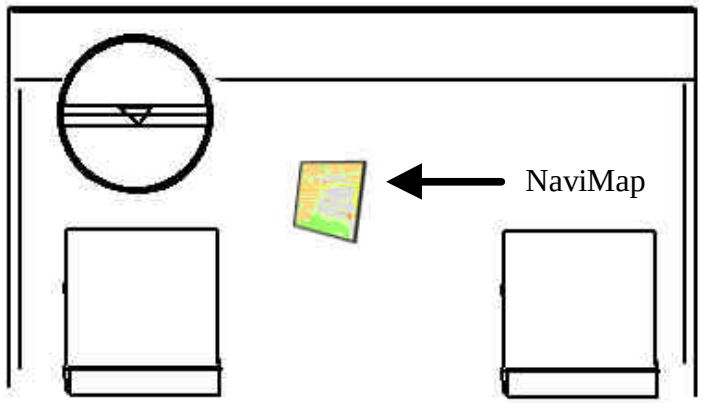
When returning from the first field visit we had seen that the drivers did use waybills during their workday. We also saw that the addresses often were not as detailed as we thought they could have been and that although the drivers found their way to the right address the way-finding was sometimes hard and time consuming. We first followed truck drivers while they were working in their home area, and we found some indications on that the NaviMap system could be useful. Later when our focus had sharpened, we thought that the NaviMap could be of more use for drivers that did not have the knowledge of the region that 'our' drivers had. We decided to look more at how the waybills were used by the drivers, as we, when working with our material, had become curious about the possibilities to use them in our design. We also saw that the cabin was designed in a way that supported the driver when driving and that the drivers used their knowledge about the load to find the right way. We could not deal with an issue of re-designing the whole cabin, but to keep the system out of the way when not needed, and easy to focus on when needed. In the Sjuhalla-example (see appendix C), which is from the first day in a truck, we observed how the driver used the environment to find out where he was and which way he should go.

There is, as we have mentioned before, a distinction to be made between navigation systems and positioning systems. Navigation systems are used in the truck, or car, as a single system while positioning system can be designed for use by someone on a remote location wanting to control the position of the vehicle. GPS can make both systems possible. When talking with truck drivers about the technology they first mentioned the control possibilities, or risks. The haulage contractor on the other hand was interested in systems that gives the traffic leaders an overview about where the trucks are, which perhaps can simplify the planning process of which truck to pick up at a certain location. After thinking carefully about this we decided that we did not want to make the NaviMap showing the position of the truck to others than the truck driver. We believe that the system should be designed to support the driver, not to keep him under surveillance. This is a political decision that is taken by us in accordance with our conviction.

In this case the system should support finding the right way to the right address, when the driver needs that help. At the same time it can be helpful to know where the places are in relation to the trucks current position when deciding which way to go. We have found the truck drivers to be very competent to find their way to the right address. Even if they do not have an address reference that is detailed, they know where to look and they do not hesitate to ask somebody to find the place. The drivers may call the office to get more information, ask the local delivery firm, look at the information board or call up a colleague. Talking with colleagues and persons on the

streets may be very nice because it is a break in the workday. As designers we would not like to be the cause of making such conversation difficult for the drivers to defend. In some of the conversations that we have heard between drivers, and drivers and traffic leaders, hints about where to go are given both in the form of advises and in form of short stories. By letting the navigation system guide in a way that the driver is aware just of what the navigation system tells you can disturb those conversations. One example of a system solution that, we think, works in this way, is when the system shows directions with arrows for each turn that should be taken. Our decision regarding this aspect was to let the NaviMap act as a map, with the difference that it shows the trucks' position and adjust it self to the area of interest. Then the drivers still have a chance to construct their own understanding about the right way, an understanding that will be a part of their experience the next time they came to the place. The NaviMap displays the information in a similar way all the time, making it easy to look at it and see where to go.

A cabin is not a very big place, although it is bigger than many passenger cars. A truck cabin is designed with a large front window and smaller windows placed on the side. The design makes it possible to get a view of the surrounding at a glance. In the cabin there are different artifacts for communication such as a cellular phone and a communication radio. In front of the driver there are instruments needed for the drive such as the speedometer and tachometer. At the right you find the stick to control the gearbox. Between the driver and passenger seat there is a motor cover and behind the



Picture 2 sketch of where to place the NaviMap docking-station in the cabin

driver the bed, if there is any, is located. Almost every area in the cabin is used as places to store stuff needed for the work. The radio communication set is placed above the driver seat, or between the driver and passenger seat.

Picture 3 A folder with waybills placed at the passenger seat. A handwritten pick-up list is placed on the engine cover in the middle of the cabin.

The waybills were often placed in the middle of the cabin, or on the passenger seat, in a way that they should be easy to reach. At the same way we wanted to make the NaviMap as small as possible without making it difficult to make sense of the map when just glancing at it. We decided to make it portable so that the driver could place it where he wanted, for example to keep it on the steering wheel if wanted. The address is represented in barcodes on a to the waybill attached note, or printed directly in connection to the address. When programming the system the driver takes the waybill and brings it to the barcode reader. Waybills are only available on delivers, when going to a pick-up point you have to program it in another way. On information boards there are maps with street indexes, that in the same way as waybill easily could have been provided with barcodes. The NaviMap is therefore designed with a barcode-reading pen on the top that makes it possible to get the information directly from the information board.

Because pick-up requests, or orders, are coming from the traffic leader also when the driver is not ready with the deliveries there is no limitation regarding when to program a new pick-up location to the system. All delivery and pick-up points are marked with green dots. We have thought about giving pick-up points one color, and delivery point another—to make it possible for the driver to see what is what. The question is if there is a need for this graphical user interface issue, because of the use of waybills. If there are waybills they represents delivery points. To design a system for the planning of work would be a very complex system, therefor we have decided just to support the navigation and not make any difference between loading and deliveries.

We have seen that the drivers drive differently when they have a single truck and when they are driving around with the trailer. The trailer makes the chauffeur plan their route regarding where to place it when going in to a small city or when it is not needed. We have seen some examples on when

the drivers take chances, not knowing whether it is possible to turn around or not. Sometimes the chances are inspired by what colleagues has told about the road, other times they are trigged by missing a road—forcing the driver to turn around.

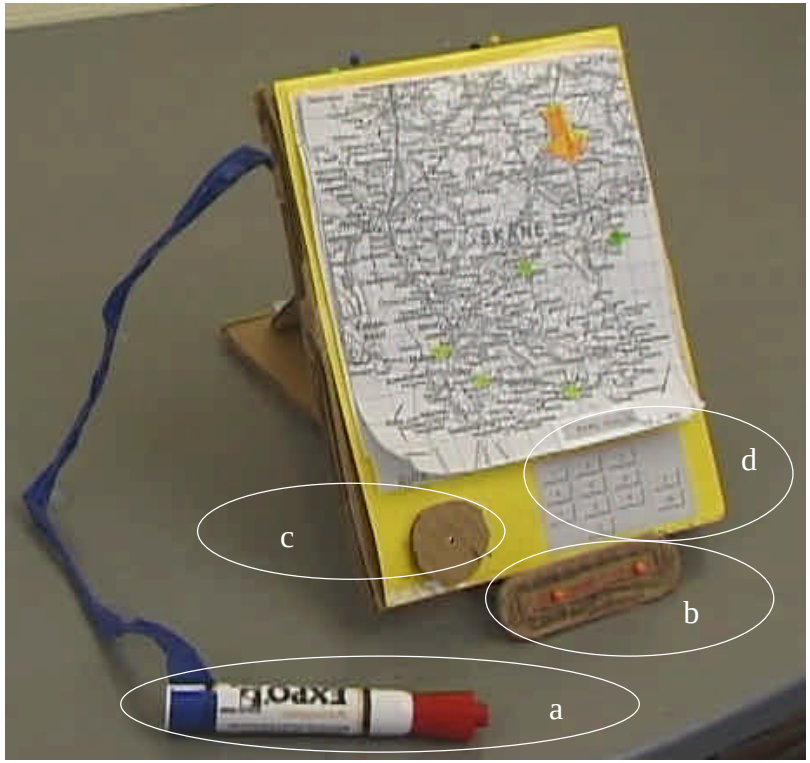
Picture 4 High detail zoom level. a) The dot represents the delivery address. b) The pointer is representing the trucks position and heading

Having a single truck it is possible to turn around on smaller places, but with a trailer it can be quite complicated. This made us think about the zooming function. There were different alternatives to control the function—physical buttons or a turnable knob. We decided to have the latter because we wanted the zoom to be without degrees.

We thought of the possibility to use a Head Up Display (HUD) showing the on the windscreen. The HUD could be used to display map information in front of the driver, making him able to see through it. For example you could have used the technique to tag road signs of special importance for the driver. When snowing there is a problem with signs that are covered with snow and thereby not visible for the driver. A thought was then to let the information on the covered sign be displayed on the HUD. On occasions when there is no snow the displaying could be so that the relevant signs where lit up. Although we thought it was a nice idea, we have not included it in the design of the NaviMap because it forces us to decide what information is important for the driver, something that is up to the driver, and what is important differs from one situation to another. We feel that the possible use of a HUD as display for the NaviMap in a truck cabin is a very interesting issue and that it is possible to add it on later to the NaviMap.

When doing the design we made a mock-up of the NaviMap. The result is shown in picture 5. Inside the vehicle we have decided to place a docking station in which the NaviMap, sized 210*170*15 mm, is placed. On the docking station a barcode reader is placed on the bottom. The map is shown on the 150*150 mm touch screen. With a knob in the lower left corner you settle the infinitely zoom at the level you wish. On

the other side there is a keypad with buttons from 0-9, Cancel and OK, and on the top we have placed a barcode reader pen.



Picture 5 The mockup of the NaviMap. The white board pen is representing a hand-held barcode reader. The NaviMap is on the picture placed in a docking station.

a) a penbased barcode reader, b) barcode reader at the docking station, c) turnable knob, d) key-pad

With the barcode reader on the bottom of the docking station, the user easily can scan any waybill, and the delivery point pops up on the map. The destination points are shown with green dots and your position by an orange arrow. If wanted, the closest drive-able way can be shown with a red line. Pressing the next destination point activates this. When no waybill is available, as when the deliveries are done and the pick-up begins, the keypad can be used to get the data into the system. It is then possible to use the loading destinations' telephone numbers to program NaviMap. By mapping the information from the database at the Telephone Company, the address can be found. Another way could be by fetching the coordinates of the address from the Geographic Information System and type them in to the system.

By marking the paper with barcodes it is made visible for the user that it is tagged. The waybills do already have barcodes, which are used at different times by different professionals. The barcodes represent different kinds of information connected to the waybill. The barcode will be grouped with the address in text, which means that their relation is made clear and showing how to hold the waybill under the barcode reader.

The address references can be stored in databases in a centralized way, meaning that they are all updated on the same time. An example of a centralized storage is the use of a telephone catalog or some other form of list. In this way the

address of a company is always updated. The address is connected to the company, and if it will move the barcode will represent the new address. On a map every location can be represented by a x and y coordinate. Using coordinates instead of addresses can be said to be a decentralized system of telling the system of where to go since they always are referring to the same place.

Barcodes can easily be printed on paper, not just to waybills. Paper is easy to handle and easy to copy. Because barcodes can be copied too, the address reference can be saved if wanted. For example it is possible to from the Internet get maps over a location, print it out and then attach the barcode and text reference on it. Although we have not designed or found if there is a need for this, the flexibility of addresses makes it possible.

An alternative to barcodes is to scan in text and let the computational power interpret the text and match it to a database. To scan text, for example with a scanning-pen, is something that is possible when for example choosing titles from a printed list. In a moving and shaking truck cabin, due to what we have seen, it seems easier to hold a paper in front of a barcode reader and at the same time keep on driving, than it does to scan text with a scanning-pen.

Enlightened

The design of the NaviMap was not made in a single day. We made a mock-up one day, we let it rest for some time and then returned to it with more inspiration and rethought details. It always takes time to gather all the impressions and to create an understanding for the work that we would like to support. It is an ongoing process. In the process of gathering you find new things to support, and others that not are important. You think the design through and discover things that are good, and bad, informed by the fact that everything always can get better. And then, one day, we were satisfied with our design—it was good enough.

Methods

Decisions taken are effecting the design. When 'matchmaking' a technology you have a technology that will be effected by your decisions. One part of the decision taking is to try and think about alternative technologies using methods so you are aware of what you are doing. Looking at a work practice, analyzing it, is part of exploring our way of making good design.

In this chapter we will describe how we have been working and which methods we have used.

Empirical studies

Field Studies

To design something that will suit a real work situation we are convinced that you have to look at the work, when it is done. We want to capture and understand the activities, and in this way be able to design artifacts that will support more than just a single action. To accomplish this we have been using video cameras, as a complement to the observations.

We have found that asking questions in 'real time' is a great source of information. The questions might intrude the work, but we have not felt that the drivers we have studied have been bothered, on the contrary they have seemed very happy about speaking of their work. If they have changed their ways of doing things, we do not know. We believe that the long hours, sometimes as long as nine hours, of being in a small driver cabin makes the driver and the observer to get to know, and feel comfortable with each other.

Filming

'Is it okay if I use a video camera?' 'Of course—as long as you do not film me!' (Initial conversation with a truck driver six a clock in the morning, 1999-03-12)

The focus has been on one person at a time, his surroundings and the people that he interacts with. We want to know what he is doing and understand why he does it in the way he does. The videotapes have been used for interaction analysis. The logs from the interaction analysis are lying as ground in our process of trying to understand the work.

During the filming in our field-studies for the Navimap we have used a hand held camera and asked questions when there has been things that we did not understand or wanted more information about. It would have been possible to have a fixed mounted camera in the truck, but then we would lose the flexibility of changing focus from the driver to the road, traffic signs and so on.

Our TitleTag Workshop

As a technique to involve users within the project we choose to arrange a Future Workshop (Kensing & Halskov Madsen, 1991). Because the MP3 music storage format is quite new it gives a new collection of problems and possibilities. Our experience told us that a Future Workshop gives the users and designers a possibility to discuss the new technology concept and its use before the technique is up and running.

When planning the workshop we asked ourselves who the potential users were. The answer was a mix between IT-design students and 'ordinary' people. In principle everybody having a personal computer can use MP3-files which to us seemed to be a fact to be mirrored in the constellation of the user group. Before the actual Future Workshop we had a lot of ideas about the technique and how to use it. The Future Workshop gave us an idea about the users' adaptability of the technology concept. We introduced our ideas about the use of a scanner-pen and the two participants seemed to like it a lot.

Technology-user matchmaking

In the technology-user matchmaking process the designer has a technology and is looking for users and areas of use. Technology-user matchmaking (Bly & Churchill, 1999) is another chapter in the story of IT-design and it is a new experience for us. We learned about the Paper Palette (Nelson et al., 1999) that we thought was very interesting in its current application. In this section our aim is to describe our matchmaking process—from the initial efforts of sense making, through visits out in real environments to the ideas of in which areas the technology concept could be used.

Game, Set, Matchmaking

As designer you may see new visions of possibilities when looking on how the technologies has been used in the past and are used in the present. At some point it may be good to play with thoughts about using the technology in new places. Our experience tells us that the frame of references may differ from designer to designer, from person to person. As an example we, when thinking about matchmaking the technology concept, saw possibilities in areas where we had been before, or at least were interested in. We have experience of carrying out projects. We know that to succeed you need courage, fantasy and common sense. At the same time as we have our experience you can say that it was a new situation because we had never before tried to apply a technology on a use area that we where not convinced needed it. Fortunately we after a while found good matches of potential use-areas.

If the technology is flexible, like a concept of technology can be, it may be possible to make an elegant solution within the new domain of application. If the technology is rigid it may be difficult. The development can be technology driven or user driven. One way is not better than the other is and both are necessary to make the product development as good as possible. In the beginning the development of a technology it is used by "early adopters" (Norman, 1998 p. 15) that beyond

the technology given are seeing possibilities, no expense considered. After some years the technology matures and the technology for its own sake of technology is disappearing—it should be used for something that makes sense and its application should mirror the possibilities.

When having a technology concept at hand you may see problems that needs to be fixed, without having the possibility to do anything about it within the task of matchmaking. The technology is only good for certain use situations. In our matchmaking process we tried to find applicable areas of use. The technology serves as a limit for what is possible to do. The question is about when to call something matchmaking. How much is it possible to change the technology concept before it turns out to be something completely different from what it was before? The technology restricts and frames the area of application. To which extent is it possible to change the existing technology into a preferred one?

The matchmaking process can be said to be about the designers to see areas of application for the new technology. In that case it is technology driven. When the areas of application are found the process is more user-oriented. It is both about finding areas of use and users within that area. The idea of the designer, the potential match, may not be relevant in real life, but when testing the idea the designer gets feedback and data that like a ball can be thrown at the 'plank of reflection'.

The process of getting ideas

To see where the Paper Palette concept was applicable meant that we tried to find groups of users that could benefit from letting the apprehension of the computer move from the foreground to the background and have paper with barcodes printed upon that represented something inside the computer. At first we thought of real estate brokers, officers at the local airport, the inspectors at the fire department and other kinds of inspectors. We decided to visit the different workplaces to get an initial feeling for the work and then continue to cogitate over the possibilities. Said and done. We visited the airport and were briefly told of how they did when to check in passengers and balance the aircraft. We talked with a real estate broker, mostly about working on the field with cameras and data about the object. We also visited the fire department and talked about their navigation to places of emergency. But we did not find any area to apply the Paper Palette concept in. To be able to find a use-area, we felt that we had to construct a better understanding of the benefits of the concept.

To the technical parts of the Paper Palette concept the role of the computer and its relation to the users is central. The design of the application shall support unplanned actions, not impede them. An example of when this could be useful is when you want to be flexible and able to handle the unexpected. The Paper Palette does this by not forcing the presenter to follow any pre-specified order, instead it is allowing him to choose between his slides freely. Before we understood the characteristics it was difficult to find the areas. Therefore it

was important for us to reflect and understand the Paper Palette concept.

We formulated an idea. Mostly it was an idea of a simplified method of programming the navigation system found in some car models. The idea was about using barcodes as input, each barcode to represent an address outside in the real world. Another idea was a support system for finding MP3-files. The idea is based on the fact that it is difficult to find MP3-files when they are stored on the computer hard disk. If you do not know where they are stored you have to use the search engines of the computer. In this idea we thought about using barcodes, but since they are difficult to interpret we chose to work further with the idea of using text and a scanner-pen reading it. The text in the list is taken from the file information stored in the MP3-file.

How we have worked with the material

From our days with the truck drivers and at the haulage contractor, we had a lot material. From the first two days of truck riding, there was especially one case, Joey and 'the Sjuhalla example' that we found interesting. It was an about 15 minutes sequence of which we made a detailed content analysis. This analysis was very fruitful and gave us great insights in how Joey used his experience and different information sources in the surrounding to find the delivery address. What we also realized from this was that it can be hard to find an address even though it is in a quite familiar area (within Blekinge). Although Joey had a lot of experience, this was an area he had never been in before.

We made the visit at the haulage contractor to see how the traffic leader worked. This gave us a better overview of 'the other side of the work' and was important for our entirety insight. The film from this session we have used to understand the work at the office and how the chauffeurs start their workday with getting the folder with the waybills from the traffic leader. We also saw how incoming orders were handled and planned into the system.

Our last two days on the road with truck drivers was on the Malmö-line. We thought it would be richer of examples of finding the right address. To some degree it was, and it was also a good example of what can happen if somebody else has loaded the truck. We also got an interesting example of how the chauffeurs cooperate when they are two in the same area.

After this we entered the design process and made a mock-up out of the experiences from the field studies. When we then started to write more about our findings we returned to the films several times to look at different occasions. The material grew from day to day and we saw and remembered different things the more we melted the iceberg of the truck driver’s workday.

For example 'the Sjuhalla example' was at the beginning only a case where the driver was unsure about the exact way to drive. When we afterwards began to analyze the situation

deeper this was confirmed. After all he did find the way, and he never really chose the wrong way. But he was very open and talked a lot during the drive, which revealed a lot of what he thought about. He held the waybill in his hand all the time and repetitively loudly read the address, watched the signs and compared. When he at one moment looked at the terrain and told us how he could imagine what the house would look like and be located, we remembered what he said about loading and thereby seeing the windows himself. We then came to the conclusion of how he used this information to create a representation of the location and surroundings of the house.

It was not only the films that made us get a deeper understanding. Our memories and discussions that came out of this also helped us in our understanding of the truck driver profession. An example of this was from the ride with Perry. He should drive to a place in Skåne. Since he had a little extra time this day, he decided to take a road that Henry had told him about the day before. To the story belongs that one of us, the day before, had been following Henry when he missed one of the roads he had planned to drive. The mistake depended on that we talked about other things… However, the day after Perry takes just this road, since Henry has told him that is possible. Our thoughts is that Henry has overheard Perry's route for the day and then told him about the closest way i.e. the one he missed the day before. Perry decides to try the road since he has a little extra time and since it is Henry—the road descriptor—who had said that it was possible.

We have also shown and discussed our material with Frank Lund, a master student from the Space and Virtuality studio at Malmö University. He has studied truck drivers driving longer routes in Europe to and from Sweden. Apparently there is a lot in common also with truck drivers driving in Europe, although they often drive at well-known routes. Frank showed us a case where one of the drivers got a loading at a place where he had only been once before, and then he just followed a colleague. Since it that time was an extra-ordinary load—fruit instead of ordinary electronic parts—he said that he had a vague memory of being there before. He looked in three different maps with different scales. He also called the colleague he had followed, but he did not remember, so the driver had to manage it himself in a way we have seen in our material.

Rounding off

By using the methods described we have got an understanding for the truck driving profession. To be a truck driver is about much more than sitting in a truck and drive from place A to place B or reverse with a trailer.

Reflections

Thoughts about the relation between Tacit Interaction and Calm Technology

Nelson et al (1999) introduces a new paradigm that they call *Tacit Interaction*. In this section we are trying to relate this new concept with *Calm Technology* (Weiser & Brown, 1996).

In figure 1 we try to visualize our way of looking at Tacit Interaction. It shows the relations between some of the concepts that Tacit Interaction is based on. The origin of Tacit Interaction is in a human centered perspective, letting the technology support the human activity. Two vital aspects are the human perception and human action.

Our *human actions* are closely intertwined with our *human perception*—what we hear, see, feel, smell, and taste, or what we *percept* with our five senses. That many part of today's computer technology are attentive to the perception can be described in terms of a metaphor that the computer can be said to treat the user as a maintenance person whose only task at hand is to serve the machine. Human perception can go from being very attentive aware to only subtle aware (Pedersen & Sokoler, 1997). Different tasks need more or less of our attention. Hereby the human action on the other hand, can go from being intentional and premeditated to automatic or

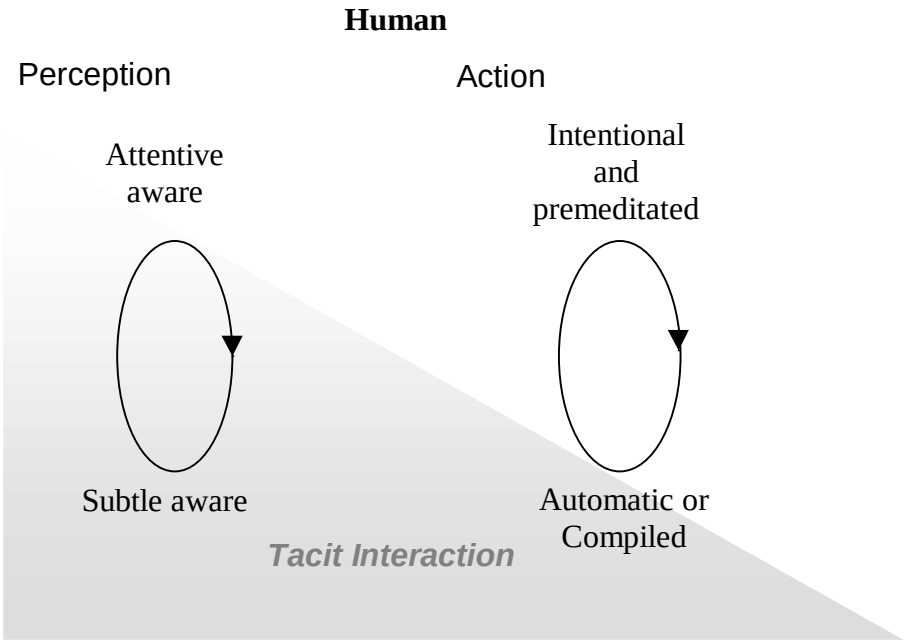


Figure 1 Tacit Interaction visualation model

compiled. The more used to a specific task we are, the more compiled it will be. Taking an example from our own experience learning to drive we recall that in the beginning of the learning process lots of attention has to be given on handling the car in the upcoming traffic situations. The coordination between clutch, braking pedal, steering wheel, gear stick and accelerator pedal is high attentive when trying to make the car move and staying on the road. The more

training, the less attentiveness has to be given the different actions during the drive. After a few years experience of driving you do not think about the single isolated actions but the driving in its entirety. If something extraordinary happens focus is given to this, followed by an according action decided by the driver. This decision is based on signals percepted from the car, the environment and from the experience.

In a meeting with with Frank Lund at the University College of Karlskrona/Ronneby (1999-04-20) we watched and discussed sequences from his and our field material. When watching a part from one of our films (band Hi8 1 at index 9.14.59 to 9.22.50). Frank told us about one of his experiences regarding how the truck drivers feel the road through the cabin. In the newer truck the cabin was air damped and in the older it was not. This affected the driver in the newer truck because he had difficulties feeling the road—the new technology removed one of the ways of interacting with the driving environment. In the older, the difference of age was one year, the cabin was spring damped which meant the driver could get the information through the wheels, the cabin and the steering. In the air damped cabin this feeling should be substituted by a thermometer. The driver in the old truck mentioned that he wanted a thermometer as a complementing artifact to ensure that his feelings were correct.

Data about our environment are not only gathered through the eyes but the whole body. You can feel forces that influence the performance of the car. The metaphor of a computer as a box and a screen are assuming the screen as a central place of communication. Graphical User Interfaces are based on the assumption that the information will be showed on a screen. In computers with loudspeakers the output may be given by sound that complements the data on the screen. In the ideas about Calm Technology Weiser and Seely-Brown are describing us as being 'attuned to' different things in the surrounding environment. They write '[…] by placing things in the periphery we are able to attune to many more things than we could if everything had to be in the center. Things in the periphery are attuned to by the large portion of our brains devoted to peripheral (sensory) processing. Thus the periphery is informing without overburdoning." (Weiser & Brown, 1996 p. 4).

Often current computer technology does not support this kind of peripheral information gathering (Ishii & Ullmer, 1997 p. 3). It has to be managed in a specific order and does not take any consideration to our human perception. Also this technology can sometimes work in the right way, for example when writing this text we do not think of the typing. It can be described as a compiled action since we are used to the keyboard. On the other hand, when wanting to draw a sketch a lot of attention has to be spent on this, at least when using Microsoft Word97[8].

[8] Microsoft Corporation copyright 1997

We are seeing a relation between Tacit Interaction and Calm Technology. An example of Calm Technology is the dangling string (Weiser & Brown, 1996 p. 6). The dangling string is a "plastic spaghetti" (ibid. p.7) that are powered by an electronic motor. How fast the spaghetti is spinning is controlled by the intensity of the network. The rotation is intended to make the familiar user aware of the intensity on the network. It supports the human perception in a calm way through the sound and wind of it. For example if you are surfing the Internet and the response from the computer network is very slow, you can peripherally, by looking, feeling or listening, get the information that the net is intensively used for the moment, since the dangling string is dangling very fast. You do not have to open the task manager or ping the servers, to get the information.

Perception and context

Information can be found in (at least almost) anything, but the situation that we are in tells us if the information is relevant. At certain places we expect certain things, for example we are looking out for cars that approaches fast from behind when driving on a highway, and when we are driving on roads in the Swedish woods we look out for elks or fallen trees that blocks our way. Information is all around us and our experience and imagination seems to use the context to tell us what information is relevant. Obviously this is working rather good in the 'analog world' of physical elements. We use one or more of our senses and the information is filtered and the world is understood (Åstrand, 1992 p.32-34). When an obstacle on the road appears it gets higher attention than everything else.

In the digital world we often find ourselves reading, for the moment, useless information in 'dialog boxes' and similar. Sometimes information of great value and internal computer data is presented in the same way, maybe even in the same textbox. The problem of this is that one always has to read the information to know if it is relevant for you. Why do computers so often force us to treat information as obstacles on a road? Our aim in both the TitleTag and the NaviMap is that the information shall be at hand when needed and when there is time to deal with it.

One way that technology has to get our attention is *notification*, a sound, blinking or turned on lamp etc. This kind of intruding way of informing a user might be annoying, but sometimes that is what you want. Another way is to have the information always showing. An example of this is a speedometer, and those of us who have driven a car with a speedometer with a display just showing the current speed in digits, knows the feeling of loss of overview when accelerating and how the digits changes to fast for our eyes. When you are familiar with the speedometer a glance at the speed hand gives you a good idea about how fast you are driving.

One way of dealing with lots of information is to keep the information to the object (see Norman, 1998). Another way could be to design an artifact to use the situation at hand to

reduce not relevant information, of course by the choice of the user.

Taking the input into account

When describing Calm Technology Weiser and Seely-Brown mostly talks about how the design of technology may be designed to let us be and to make us calm. One of the relations between the Calm Technology and the Tacit Interaction is that the latter focuses on how to make the interaction with the computational power calm. The similarity in the relation is that both concepts are about how to make use of different senses to be able to focus on what you are doing instead of what the computer, the technology, is doing. Another relation between the two fields is that they are studying how technology relates to the users. A difference that we see is that Calm Technology deals with computer output entities while Tacit Interaction also takes the input into account.

Sometimes computer technology can be described to be on a very attentive level of the human perception and actions taken using the computers tend to be intentional and premeditated. When using the notion of Tacit Interaction the aim is to make the design of computer technology use subtle awareness and automatic or compiled action so that the user's focus can be on the primary task. For example when using the Paper Palette the focus is on manipulating the slides and not the menus in Microsoft PowerPoint.

We have designed NaviMap and TitleTag with the two concepts in mind. We have tried to support the concepts in our two design solutions. Because we have done the technology-user matchmaking (Bly & Churchill, 1999) of the Paper Palette we have seen the Tacit Interaction as a main issue to deal with. At the same time we are inspired by what is written about Calm Technology. The NaviMap is designed to be used by chauffeurs in trucks, although the idea of interaction may as well be used in passenger cars. The system shows a map that are changing and are placed in a way that the chauffeur may see it when he wants to. The drivers seem to be aware of different things when driving the truck, for example the size and shape of the cargo. At the same time the driver may easily change the center of attention from the cargo to the road ahead and maneuver the truck so that unnecessary and time-spending troubles are avoided. Designing a support system for navigation that should fit in the cabin must not disturb this awareness. Therefore it is important that the interaction is tacit. The Tacit Interaction is accomplished by the use of physical objects, in our case waybills, that are tagged with barcodes. The physical objects are easily sorted and placed where they are reachable when driving and the barcode reader is placed where it is easy to find if support is needed. In TitleTag the physical objects are used in pretty much the same way.

Information overload

In the end of December 1991 a plane crashed in a small field in Gottröra, Sweden (Mårtensson, 1995 p. 305). An automated

function that neither the pilot or the company they worked for were aware of had started to increase the power of one of the engines when the other was damaged by ice. During the four minute long flight a lot of things happened regarding both the engines malfunction and the information related to the engines. The pilots could not get the information they needed from the system to take the right decision. They were overloaded with information from the system, which instead made them rely on their common knowledge from flying (Ibid, p. 315). All the messages were presented in the same way not considering what was most important at the moment.

The accident briefly described above can serve as an example of what can happen when there is automatic functions in the background, which we are not aware about. To fly an airplane is very complex and we can see that the pilot is dealing with a very large system. It is therefor important that the human/machine situation works and that the human gets the most appropriate information for the actual moment.

Harper and Hughes write about automated assistance systems for air traffic controllers. They are talking about an important issue regarding responsibility and automation. If the system is automated there still must be an "appropriate mix of decision capacity" between the system and the controller (Harper & Hughes, 1993 p. 132). We have the opinion that if the right to make a decision is given to the computer it should be so obvious that you never have to question who is responsible. It must be handled with outermost caution.

"A major problem for designers, given that human beings are notably bad monitors, is to devise ways in which any automated facility could be elegantly overridden by the human operator; a matter also of keeping the operator 'warm', or engaged, throughout the period of duty so that if required to over-ride the automated system time is not wasted finding out what needs to be done." (Harper & Hughes, 1993 p. 132)

Being warm is in a note to the text described by an example when a DC10 ran of a runway in 1984. The cause for the incident is said to be that the crew trusted the aircraft's automatic system. When something went wrong, the pilots were not capable of recreating the 'picture' of what was needed to do. "Trusting automated assistance very often means that operators, in the case of failure, have to make inquiries to determine what needs doing: a 'warming up' which can be fatal." (ibid, p 143). When driving a truck the driver has to be aware of the changes that are around him. There are surrounding cars, pedestrians and bikers. The vehicle has some dimensions that are critical to be aware of for a successful drive such as height, width, load and length. Regarding trucks the height are important and it is due to our understanding not unusual that trucks get stuck under a low bridge because the driver forget he is too high for the free height. In some of the trucks we have been riding the height has been shown on an attached note at the instrument panel. The truck cabin is sometimes lower than the equipages maximal height why the driver may forget the superstructure.

Another example from what a driver told us is a certain place where the bridge does not allow heavier traffic. The traffic is re-directed to a newer road and the signs are informing the driver which way to go. The problem, as we were told, was when going to a company near the bridge for loading or unloading—a task that takes time. The point is when leaving the loading place to drive back again. Then the bridge with the limitation is on the right side and suddenly the driver finds himself doing an illegal and perhaps dangerous operation passing the bridge—because the sign that was noted two hours earlier was not remembered at the present time.

In a similar way as pilots in an aircraft can be stressed by too much information on a too high level of perception at the same time, the truck drivers can be disturbed by the same reason. If one source of information takes to much attention the truck driver may lose the picture of the traffic situation.

Calm in CSCW

A too good design?

Very few activities are done in total isolation, even when it at a first glance might look as a 'one persons job' it is seldom the case. In the process of finding a street or a company the drivers is not left alone. One of the first things the drivers do when they get the waybill is that they look at the address to see if they know where it is, and if they are unsure they ask another driver or the coordinator before they go to their trucks. If one driver has problems in finding a particular place he often calls another driver to hear if he might know the way.

When we designed the NaviMap we considered this cooperation between the drivers. How does a navigation system affect this way of working? With good navigation system you do not have to call anyone for a road description. Even if the purpose of the call is to find an address, the result is more than that. Road description is a good reason for calling, and the call is a way if social activity. Would it be legitimated to call a colleague just for a chat?

Design for CSCW

The idea behind the mobility of the NaviMap is rooted in the cooperation. Today the drivers might use an ordinary map as a mediating artifact when they are at the same place while talking about how to find an address. The NaviMap will function in the same way, with the difference that the final destinations can be pointed out.

In the NaviMap system it is possible to see your own position and the positions of the delivery addresses. Another feature is that the truck drivers have the possibility to show their own position to others, or in other words the drivers can see each other’s positions. This feature can be good for coordinating work (for example load shifting) or maybe coordinating coffee breaks.

Thoughts about the relation between Work practice and Design

Studies of a work activity can be very fruitful, you might see things you did not expect and you might understand reasons for actions that have been unclear before. In the research area Work Practice one central part is to do careful studies, to create an understanding of a specific activity. The specificity of a situation and the specific context are two concepts of great importance.

In design (e.g. Human-Computer Interaction) 'everyday assumptions' are seen as a good way of describing the world. Often several individuals will use a designed artifact, or perhaps the artifact will be mass-produced and the design will effect millions of users. Some design assumptions are good. For example is the assumption that it is hard for people to read red text on a blue background, a satisfying generalization even though it might be wrong on occasion. The advantages of doing this kind of generalizations are that it is time and effort saving, and in this case the designer can worry about the problems of the work activity instead of a technical solutions.

We have been looking at three different truck drivers, driving for the same company, and we feel that we have got a rather good picture of what their work is about. But how should we use that picture as a standing-point for our design? A need might be obvious, but the design can still be very unclear.

When we think of what will suit the situation, we try to relate to the artifacts already in use. We have seen that the waybills are actively and frequently used, and we have seen that it is used for different purposes, such as getting an overview of the route. The waybills are the carriers of most of the information that the driver needs. In a design of a navigation system it might be easy to ignore the waybill. A worst case scenario is perhaps when some bad designers removed the waybill, thinking that with a good navigation system the driver does not need to know the address, the company name and so on. We shiver at the merely thought, because due to what we have seen in our empirical studies waybills are not just pieces of paper but serves for example as representations of the cargo.

NaviMap is useful only for a small part of the entirety in the truck driver profession. It is not the only thing you use in the activity of finding the right way. It is important to be aware of the fact that the profession contains very much more in its complexity. Many activities are going on in parallel besides finding the right way, and all should be considered when designing a new tool.

Our aim is to make the design function on a 'ready when needed' basis. We want the artifact to melt into the work practice and the interaction with the artifact should be a well-integrated part of the work. The technology should be in the background and the computational power should be useful in the real world when needed. It should be designed in a way that the user does not have to focus on the artifact when it is used, but on the task at hand. The truck driver, for example, is

not interested in using the NaviMap but how it can support him in the process of finding an address. If it can not help him or if he does not want help, he shall have the freedom not to use it and not be disturbed by it. This way of using the technology can be seen as tacit and the way you work with it can be seen as Tacit Interaction.

Much of designing artifacts for a work activity are about letting the new design melt together with the other artifacts, the surrounding environment and the context of use. With the understanding that we have (from observation as well as from earlier experiences), we 'know' that just giving the drivers portable computers with a map application would not work. The reason for this is that the portable computer is not designed to the cabin environment. From what we have seen of their navigation today, we dismissed the navigation systems that helps you find the way by showing arrows pointing in the direction of the next turn and we chosen to show the way as a red line on a map. We have seen how carefully the drivers are planning their route, and we want to support this way of working (as an activity) rather than give them information for each action that is to be taken. The red line will always be available yet not interrupting or demanding attention.

The studies that we have done are qualitative and the design is made with some specific situations in mind. Although, we believe that the design would suit many truck drivers, that not has a well-known route, pretty well. In our discussions with Frank Lund we have found similarities that indicate that our design would be well suited for these drivers' needs too.

Conclusion

From two examples, NaviMap and TitleTag we have in this report discussed Calm Technology and Tacit Interaction, two areas that we believe will grow a lot within a short period of time. We have also found that there are some contradictions between Design and Work Practice, and we have tackled those in what we, from our experience, think is a satisfying way.

In this section we will summarize our findings.

Use of and relation to technology

Both Tacit Interaction and Calm Technology has main thoughts that deal with the relationship between human beings and technology. The technology in itself is subordinated. Both concepts are dealing with design and have humans as a focus. In the Design tradition problems are solved, most often with technical means. In Work Practice the understanding of *how* something is done is a very central aspect. When the *how* is about machines it equals the term 'use'. In this field the tradition is to look carefully, and describe the specific case in great detail.

During our education we have studied a little of both traditions and we have a way of looking at things like it is done in the field of Work Practice and we make solutions like it is done in the field of Design. There is a tension between the specific work and the design of a multi-user system. In this project, the things we have seen are detailed and the conclusions that we make are (hopefully) good enough for the drivers that we have studied, and we can build artifacts that are useful in their practice. But how is it possible for us to make generalized artifacts, from this kind of field observations?

In our design work we have created some 'Rules of thumb', rules consisting of assumptions about how navigation for truck drivers are done. An example of an assumption is that *the waybill is important.* This is surely true for the drivers that we have studied and it is probably true for many of the drivers who has got a job that, like the drivers we have studied, is about sometimes drive to unfamiliar places to deliver goods. We have not written down the 'Rules of thumb', but they are in the back of our heads all the time.

Our relationship to the technology and to work, we described as our philosophy in the introduction of this thesis. Philosophy is a big word, and our philosophy defines our values. Gregory Gargarian writes about "Freedom by restrictions" (Gargarian, 1996 p.132), in our case the restrictions are founded in our philosophy. We see the philosophy as our way of dealing with difficult problems, for example questions of integrity. It is fundamental for us not to design a system that is jeopardizing someone’s integrity. This is unless there are extra ordinary circumstances that make us, deliberately, go against our

beliefs. But if we do, we are very conscious about it. Our philosophy is a resource for decision making.

Some of the concepts that we feel has been important in our work are the 'Generative metaphors' and as mentioned above the 'Rules of thumb'. Beside our philosophy these concepts are of great value in our design work. The generative metaphors give us ways of thinking about technology and technology use. The Paper Palette is in a way enlarging how we look at input devices. Instead of thinking of the barcode reader as *the active part* of the system the piece of paper with a barcode is what is used for interacting. You are not using the barcode reader for collecting data, but use pieces of paper for controlling the computational power.

For us the concepts Tacit Interaction and Calm Technology have been most generative, they gives us a wider perspective of how to design the human-computer relation. We like to think of them as paradigms or patterns that we can use as a standing-point in our design work.

The common ground for the areas of Work Practice and Design is that they are concerned with the *use* of technology. To combine them is very fruitful. The designers can make artifacts that suits the work, and the ethnographers can be able to give a solution to the problems they see.

The end

Computational power can be very useful. Few disagree with this statement. Many, on the other hand, may say that the benefits are not worth the extra work computers requires. Of course they are right, today too much effort is put in maintenance. Although once in a while one run into some technology one really likes, in our case the Paper Palette, and one wonder what makes it so good? In this thesis we have tried to answer this question. And we found that much of the answer is in *its relation to the user*.

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Field material

Videotapes:

Dv1 Another day in a truck, Perry, 1999-03-12
Hi8-1 A day in a truck, Joey, 1999-02-23
VHS-1 Some hours at the office, Ernie, 1999-03-05
Hi8-2 The first day with a truckdriver, Henry, 1999-02-23
Hi8-3 The second day with Henry, 1999-03-11