



# Communication Tools for Truck Operators

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## i. Foreword

January 1<sup>st</sup> 1997 Volvo Trucks initiated a three year-long research programme at the Institute of Design, Umeå University. This programme was later extended until 2002. A majority of the work has been conducted at the Institute of Design, even though a number of other institutes and departments of Umeå University have participated in the research. The overall purpose has been to study different truck transport issues from a cross disciplinary perspective.

The research programme has been aiming towards, by using adequate studies and analyses, bringing up suggestions for improvements that in some way have been tested by end users.

This project is the seventh in a series on the truck operator's working environment outside the cab.

This particular study has focused on the operator's information and communication needs in that environment.

Niklas Andersson and Lars Johansson, both Industrial Designers MA in Interaction Design, have carried out the main part of the research work in this project. Tapio Alakörkkö, Ergonomics and Physiotherapy Researcher and Stina Sjöström-Juhlin, Industrial Designer MA has also contributed to the first phase of this study.

Umeå, May 11, 2001

*Bengt Palmgren*

Professor Head of Department,

Institute of Design Umeå University

## ii. Author's note

The local truck operators of today handle a lot of information and communication in their daily working life. Many independent sources also indicate that the information load will increase significantly in the near future for this user group.

Over one third of the local truck operators working time is spent outside of the cab. During this time he needs to access information concerning the goods, the route of the day and the consignee<sup>1</sup>, among other things.

The project had two phases:

The first was to investigate what information and communication needs and problems the local truck operator of today has outside the cab

The second was to present a variety of examples how emergent near market technologies could be used to take care of the needs and problems pointed out in the first phase

This report will emphasise in the latter phase a variety of examples of possible solutions.

The resulting examples all point out that a high level of mobile and wireless information and communication support for the truck operator combined with an international standardized system of electronic consignment notes, all results in total time savings between 3 and 18 %<sup>2</sup>.

We would like to thank our colleagues Tapio Alakörkkö and Stina Sjöström-Juhlin who mostly completed the first part in this project to investigate the needs and problems of today. Without their careful and consistent investigations, none of the following examples of solutions would have been carried out with such a high level of realism.

Umeå, May 3, 2001

Niklas Andersson and Lars Johansson

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<sup>1</sup> Consignee: one to whom something is shipped (Webster's dictionary 1993)

<sup>2</sup> Depending on type of work tasks and their mutual allocation. The time saving for work only outside of the cab is calculated to 8-47 %.

### iii. Abstract

#### Communication Tools for Truck Operators

A conceptual design project made by Institute of Design, Umeå University in cooperation with Volvo Trucks, Snickers Europe and Nokia.

#### Project aimed to find mobile communication solutions

The need for mobile communication outside the truck cab is constantly increasing when the demands for effectiveness and flexibility rises. This project's purpose was to investigate the truck operators needs and to see how modern digital technology can help to reduce the paper work and increase the productivity and make the operator's working situation better.

#### Wide range research methods

Research methods used include literature studies, participatory observations, hardware and software sketches and design models tested on users throughout the project. In contrast to traditional conceptual design projects, a number of working electronic prototypes of the suggested hardware were built (in cooperation with students from the faculty of Applied Physics and Electronics at Umeå University). This took the project a bit further, to show the possibilities of this new mobile digital technology.

#### Research shows much working time outside the cab

A short-range truck operator who transports provisions in medium weight trucks spends approx. 42 % of their working time outside the cab. This outside work consists of loading, unloading, communication, interaction with customers and some administration.

A communication product for this user group

must meet requirements such as: good ergonomics, work with technology of today and tomorrow, outlast the toughest climates, be socially acceptable and add valuable benefits to the truck operators own working situation.

#### Mobile Internet is the backbone

The suggested system is built up around the truck on board CPU with satellite connection to the Internet. The truck operator is connected to the CPU via wireless LAN (e.g. Blue tooth), will see information on handheld, neck- or head worn devices. To keep track of the goods Radio Frequency Tags are used. DGPS is also used for precise positioning of the truck. Logging of goods movements will be registered through gate sensors in truck and stor-ehouses.

#### Concept I: Cap Mounted Display

A monocular display unit is mounted on an ordinary cap. The unit also contains microphone, earphones, camera and Bluetooth units. The device is voice activated.

#### Concept II: Audio Collar Device

A collar shaped, soft device with built-in pairs of speakers and microphones for phone, news, music and text messages read by a synthetic voice. This device with specially designed speakers for directed sound effect towards the users ears, without having to plug in earphones. Will work with any type of garments.

#### Concept III: Arm- and Handheld Display

An arm mounted version of the handheld computer (e.g. Palm Pilot) with telephone function added. A leg pocket variant with touch screen is also possible.

Context awareness reduces stress and saves time

The fact that the system knows when and which information is wanted and useful, is a fundamental shift from today's unintelligent digital information systems when the user himself must select from all information that's available to him. This is a well-known cause of technology stress and fatigue.

In our scenario, the user just has to enter the loading bay and the CPU sends him information about loading. No more clicking through menus and typing commands.

Promising conclusions

One of the most obvious conclusions of this project is the time saving effect of between 3–20 % of the short-range truck operators total working time. Still, we strongly suggest that additional economical and logistical studies must be carried out to confirm these figures, before they can be considered as facts.

# 2. Introduction

A co-operation between Volvo Trucks Inc. and Umeå University, organised as a three years research programme, was established 1997. Within the research programme a number of different studies have been carried out. The studies have focused on the long-distance truck driver's working situation. The issues have varied from the problems related to loading and unloading, safety/security for drivers and goods, modifications of the truck's design to ethnological studies of the drivers work culture. The results have pointed out different problems and development opportunities. Especially the drivers' possibilities to communicate with, for instance, customers, colleagues, and terminal workers and transport coordinators in various environments appeared to be one of the most important fields for further studies.

The Institute of Design has also run another research programme concerning "Wearable Computers". In this programme co-operation has been established with Snickers Europe, Sollentuna. Volvo has earlier co-operated with Nokia when developing different communication systems to be used inside the cabin, and it was natural to continue the co-operation in this field. Snickers manufactures work clothes and garments specially adjusted for demands and needs from different trades. Snickers have also recently started to develop a special collection for professional truck drivers.

After an initiative from Volvo, a project with connection with the two research programmes will be established. The project will cover the truck driver's needs for *mobile* communication, especially when working outside the driver's cabin. The driver handles today a certain amount of information with equipment that is installed in the driver's cabin. The scope of the project is to study what possibilities there are for development of an informa-

tion system and equipment that is mobile, "wearable" and maybe integrated in the driver's working clothes. The ambition is to broaden the information system to cover a wider range of information issues and functionalities.

Truck driver is hereafter referred to as *truck operator* to underline their multi function role of managing the transport and not only drive the truck.

## 2.1. Project purpose

The primary aim with this study was to identify, describe and create conditions for the professional truck operator's needs of mobile communication in order to fulfil their tasks in the most effective way. Functionality of the communication system, in different work situations, was the fundamental demand.

A secondary aim was to study the possibilities to transfer developed design concepts to similar work situations with different types of users. In the prolongation the ambition was to develop commercially marketable products. The focus of this project was on truck operators of distribution trucks. The truck operator's tasks outside the cabin were to be examined and surveyed.

## 2.2. What is Interaction Design?

Designing understandable products is rapidly becoming a major issue for industrial designers and a vital part of industrial design education. Enormous advances in information technology have provided us with information-based products ranging from mobile telephones to automobile navigation systems where complexity of the technology has resulted in confusion for end-users.

Since we are an industrial design school we see Interaction Design as the combination of hardware and software design. Our simplest definition of Interaction Design reads:

“Interaction Design aims to integrate the physical and cognitive product interface into a successful whole in order to create understandable, usable and enjoyable computer-based products”.

We also often refer to an article written by Brad Weed from Microsoft who describes why he thinks industrial designers can be particularly suited to the practice of interaction design<sup>3</sup>.

### 2.3. Concrete project issues

The following issues have been our focus in this project:

- What is the truck operators' communication situation like, regarding logistics, security/safety, vehicle data, navigation etc.? Which types of communication systems are available today? What technical systems are applicable? GPS, GSM, GPRS or “Bluetooth”<sup>4</sup>.
- What information does the truck operator need in different work situations? We already know that there exist needs for alarm messages, transport planning information, load data and load security information, vehicle information, navigation and route guidance, personal planning, telephone, radio, Internet, TV, CD, etc.
- What modalities of input (speech, keyboard, touchable screens, eye movements etc.) are best for this kind of communication situations? What output modalities (voice, text/picture, print outs etc.) should be used? Where shall the equipment be placed - in hand, integrated in the clothes, mirrored in spectacles etc.? When, where, how, why, how often, for how long will the equipment be used?
- Can new communication tools/-systems be designed and developed to make the truck operator's work easier? What kind of other professionals can use the same techniques?

### 2.4. Methods

The following methods have been used in this study:

- Studies of relevant literature and the different participating companies conceptual solutions
- Participating observations of the whole transportation chain from the, buyer of the transport out to the end customer
- Conducting interviews with truck operators, terminal workers, foremen and customers
- Describing possible communication concepts by using scenario techniques
- Design of hardware and software for communication concepts
- Visualisation of different design concepts

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<sup>3</sup> <http://www.acm.org/sigchi/bulletin/1996.3/vid.html>

<sup>4</sup> <http://www.bluetooth.com>

# 3. Defining the problems

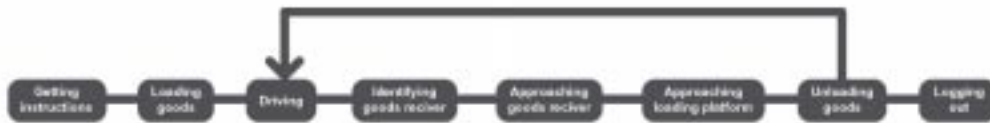
## 3.1. User Studies

The user groups that have been studied are distribution operators and delivery services. The studies identified, among other things, that there are new emerging trends for these kinds of businesses:

- Increased door to door deliveries
- Tougher competition
- Special deliveries
- Just in time
- Higher service level

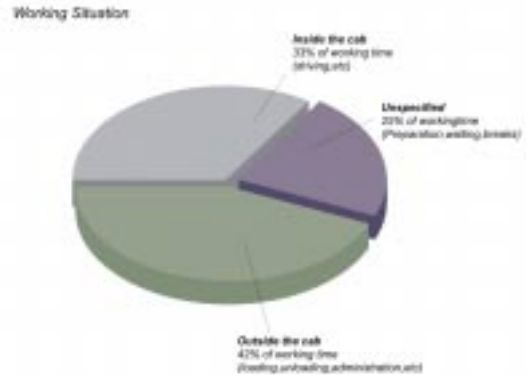
The first phase in the project started with a series of long-term observations of the truck operators working situation. Some studies were also already made in previous Volvo projects that have been made at the Institute of Design such as; Rumbling trucks – a noise level study, Climate sensitive goods, Truck for India, Trucking as a lifestyle, etc<sup>5</sup>.

The findings from the user studies, were put together as a flowchart for the truck operators typical day:



A detailed version of this flowchart is attached in this report's appendix.

The average results of our time studies showed that the truck operator working with local distribution is spending 1/3 of his time outside the cab and 1/3 of his time inside. Our interview material indicates that this ratio has been stable for at least 15 years,



and the users also feel that this situation will sustain in the near future.

The users experiences that the stress level has increased, due to tighter time schedules. Still, a majority of them are satisfied with their working situation as a whole, several of them expresses a strong feeling of freedom, though they almost never can take a five minutes unplanned stop or make

a smaller detour, without having to notify the manager.

The working environment is very tough and demanding for the operators and their equipment. The operators are jumping in and out of the cab

<sup>5</sup> All these projects are a part of the research program Safe Effective Transports sponsored by Volvo Trucks, at the Institute of Design. The projects mentioned are presented as written reports and are available from the Institute of Design (a majority of these reports are only written in Swedish).

10–20 times a day, crawls amongst the cargo and makes a dozen phone calls every day. Many of the operators in our test group confirmed that they broke their mobile phones on average twice a year, and that the belt clip in plastic only lasts less than a week. The metal clip is the only type that can handle the tough treatment.

Also the operators questioned the ergonomics of today's mobile phones. Too small buttons, small screens and that it's very easy to place the speaker in correct position over the ear was some of the problems that were put forward.

This leads to high requirement standards of any new information and communication device for this user group.

Areas such as ergonomics, climate, social, and technology are some of the most important requirements.



### 3.2. Nokia 9110 user test

Parallel to the main study, Nokia wanted us to investigate the functionality and user situation when using the available 9110 Communicator together

with the Smart Forms Pro application in a transport company. The purpose with this study was to find out which functions were usable and to give Nokia feedback on the form and functions. Stina Sjöström-Juhlin carried out the field test during September–November 1999.

The Nokia 9110 was released in 1998 and was replacing its forerunner 9000 from 1996 which was the first real attempt to combine mobile phones and palmtop computers. The primary areas of use with the product are to send and receive fax, e-mail and SIMS together with the ordinary phone. All of these Nokia Communicator models have the same two primary modes: closed – ordinary mobile phone, open – palmtop computer and phone with speaker or head set.



Nokia 9110 Communicator

The form language can be categorised as sharp and stringent. The size (156x58x27mm) and weight (250g) is far over the ordinary cellular phones of today, and that is where this model has its biggest weaknesses. One user comments the feeling with the words “it’s like holding a brick to your ear”. Actually, the older model 9000 had much more rounded shapes.



Nokia 9000 from 1996

The 9110 were replaced early year 2001 with model 9210, which has on the whole the same shape and functionality as the previous model, the biggest novelty was that the 16 colour greyscale LCD display was replaced with a 4096 colour display with the same resolution.

Two companies participated in the tests: Per Svenssons Transporter AB, Stockholm and Skandi Transport AB, Uppsala. Staff members from the companies volunteered as test subjects and was trained to use the 9110 and its adjacent equipment:

- Two Nokia 9110 Communicators
- Headset
- Phone holsters
- One Nokia 5110 Mobile phone
- Celesta Smart Forms Pro v 3.44 with a specially designed form for this test
- One standard PC laptop
- Nokia Data Suite 2.0



The test procedure was the same for all subjects;

- 1) Functions of the phones was instructed
- 2) The subjects used the phones alone for 1-3 weeks
- 3) The system was set up
- 4) The functions and usability was checked
- 5) The subjects carried out the test alone for 1 - 2 weeks
- 6) The subjects was interviewed after the test

## Results from the interviews:

### Skandi Transport interview

The 9110 have a too small display and are hard to learn. There is no way to get a signature and it doesn't have a barcode reader built in. The 9110 have too many functions, which are not needed. Have earlier tried systems like Aplicom and Psion hand-held computer.

Equipment of their dreams should be very easy to learn and handle, has a small computer screen (like an ordinary PC desktop). With this device you should be able to get and give order status. It must be easily mounted in the car while driving and still possible to take out of the car. It should have a small amount of buttons and the user should be able to handle it with one hand. A built in barcode reader for waybills and pallets is handy. It must be possible to write the signature directly on the screen, no special pencil necessary. Maps would be nice to have in it.

### Per Svenssons Transporter interview

*Positive:* The phone display is the same as other Nokia phones. The sound signals are loud and very liked. The loud speaking phone function is nice.

*Negative:* It's not possible to use other features then the phone while driving. The phone is heavy and clumsy. It's not possible to reply the form while the operator is driving the truck. It's impossible to type in and send a SMS with one hand while working. The keyboard buttons are too small. The 9110 had too many features. It was hard to learn the phone and there are many buttons to push to get the correct feature. The Communicator also was hard to handle when it's open (has a tendency to flip over). There are no



plane surfaces to put it on in the car. SMS and contact card didn't work properly.

### 3.3. Problem definition

The investigations of the truck operator's working day, indicated over 20 tasks related to information and communication. To limit the project we focused on a more narrow set of tasks. The field studies proved that some of the tasks are more frequent and more important than others. Some of the need also where situated in the out of cab context.

#### The identified needs were:

##### A. Only inside the cab

1. **Obtain full rear view visibility** – for judgement of distance when reverse the truck along with elimination of the dead angle
2. **Handle the tachograph** – specify certain run for invoice
3. **Show position** – making the work easier for managers (must be possible to disable)

##### B. Mostly inside the cab

1. **Ability to navigate to consignees and customers** – finding the way, forward information to other truck operators
2. **Obtain information about traffic situation and weather** – information about accidents and other traffic obstacles
3. **Get alarm information** – Rear gable lift down, flat tyre, jamming brakes etc.
4. **Get general information during and between runs** – freezer temperature, equipage total weight

##### C. Both inside and outside the cab

1. **Get information about loading platform** – appearance, consignee, gate code and where to place the goods
2. **Get information about runs** – run order, consignment notes and time reports
3. **Get information about the truck before run** – maximum weight, fault reports
4. **Get information about sudden changes** – extra order, changes in details of ongoing or coming run
5. **Conduct general communication** – phone calls with customers and consignees, radio communication with other operators or manager
6. **Support reporting of problems and damages** – forward information on delivery problems or damages to manager and consignee
7. **Improve keeping to time schedule** – just in time, check schedules, reduce stress
8. **Maintain social contacts** – colleagues, family and customers
9. **Get entertained** – listening to radio broadcasts for entertainment, news etc.
10. **Give and get information on dangerous goods** – from customer: type of dangerous goods, from authorities: imposed route, to authorities: type of goods (at accidents, inspections etc.)

##### D. Mostly outside the cab

1. **Ability to find stored goods** – find the way in a large storehouse
2. **Get information on empty goods** – transfer information on returning, empty goods

## E. Only outside the cab

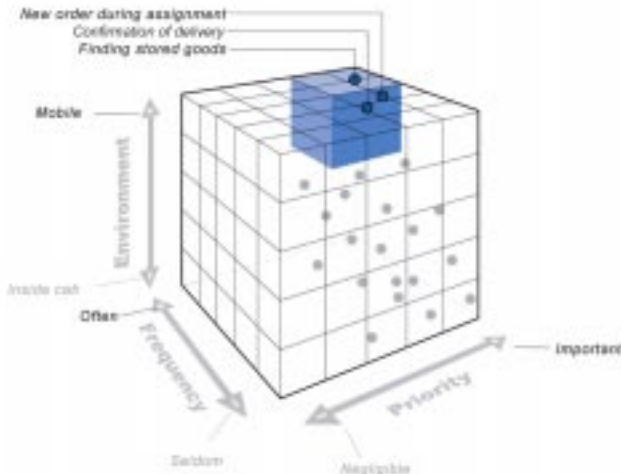
1. **Ability to identify the goods** – relationship to the other packages in the group to the same address
2. **Ability to do technical control** – remote control of loading height, ignition, door locks, alarms
3. **Get confirmation of delivery** – consignee signs consignment note to accept the delivery
4. **Make planning** – participate in schedule planning, influence organisational structures

We plotted out these 24 needs in a cube with the dimensions of Priority (Negligible vs. Important), Frequency (Seldom vs. Often) and Environment (Inside cab vs. Mobile).

During our mid-conference in Sollentuna these needs were presented to the cooperating companies Nokia and Snickers.

The discussion led us to focus on three needs:

- C4. Get and confirm a new order during assignment
- D1. Ability to find stored goods
- E3. Get confirmation of delivery



To describe the different problems that occur in the truck operators work of today, the following three problem scenarios were created<sup>6</sup>:

## Problem Scenario 1: Get and confirm a new order during assignment

Setting: Loading platform at Kranvattnet's country shop  
Transport management office at PG:s Trucks AB, Umeå.

**Persons:** Kenneth, 28 years, truck operator  
Bill, 43 years, transport leader

**Synopsis:** Bill wants to get hold of Kenneth and tell him about a new assignment. He wants to know if Kenneth can pick it up on his way in.

**Plot:** The time is 10:29 one Wednesday in September. Kenneth is rolling out racks from his truck's cargo space at Kranvattnet's country shop, 55 km west of Umeå. The wheels clatter and make a lot of noise when they roll over floor plates and aluminium plank. Suddenly the mobile phone in Kenneth's coat starts to buzz. It takes a while before the buzz is heard in the noisy environment. When he finally realizes that someone is calling, he has trouble getting the phone out of his pocket, which is placed in a wrong way. Furthermore, he has to take off his gloves before he can take the call. At that time the caller has hang up. Kenneth curses the phone quietly, and looks at the display to see who called.

**Kenneth:** - 15 69 82? Oh, it must've been Bill who called. I'll call him up a once. (He redials the number and Bill's phone rings)

**Bill:** - Hello, it's Bill.

**Kenneth:** - Hi, Kenneth here. You called me?

**Bill:** - Yep, we've got a new order that's pretty urgent.

**Kenneth:** - OK?

**Bill:** - Well, it's nine racks in return from ICA in Hissjö. They want them picked up before...eh...14.30 today. I thought you could take it when you're driving back in the afternoon?

<sup>6</sup> These scenarios are the problems that later was solved, which appears in the Final Scenarios section (8.4.) in this report.

**Kenneth:** - Hmm, well... I've to check my papers first. I'll call you back.

**Bill:** - OK. In a few minutes?

**Kenneth:** - Sure. Bye.

**Bill:** - Bye.

Kenneth goes back to his cab and checks his schedule for the afternoon. It's a pile of papers, notes and bills. He calculates how much room the nine racks will take and how much space that's left in the cargo space. He picks up his phone and calls back to Bill again.

**Kenneth:** - Hi, it's Kenneth again. It's OK for me. I'll have to leave a bit earlier from Vindeln, but it's OK. By the way, I've never picked up stuff from Hissjö before. How does it look like?

**Bill:** - We'll see... (Bill browses through his papers) ...it's an ordinary loading platform with roof. No entry code, I think...that's right, just a bell. Thomas is the name of the shopkeeper. OK?

**Kenneth:** - Very well! (Writes down the name in his hand) Do you know if my truck can fit under the roof, I mean, now I'm driving the new FM7 with extra high van body?

**Bill:** - That's right, it's much higher than the others! You'll have to test with the measuring-rod before you back in...eeh...I can see in the papers that the roof clears our old standard heights, anyway. Do you remember how high it was?

**Kenneth:** - No, that was long before my time. Can you give it to me now? (Picks out the pen again)

**Bill:** - Mmm...(pause)...four- seventy. Did you get that?

**Kenneth:** - "Four - seventeen"? (Reading from his note in his hand)

**Bill:** - No - no. four meters and seventy centimetres. (Kenneth changes seventeen to seventy)

**Kenneth:** - "4,7 meters".

**Bill:** - Bingo!

**Kenneth:** - Well, with lowered air suspension it might work...

**Bill:** - Perfect! (pause) OK...that's it, then...

**Kenneth:** - OK. Bye.

**Bill:** - Bye.

Kenneth hangs up and puts the phone back in his pocket. He puts on his gloves, climbs down from the cab and continues unloading the truck.

End of scenario.

### Problems analysis:

- The noisy environment prevents the user for using the phone
- Working with both hands at the moment makes it hard to use the phone unobtrusively
- When the communication device is placed under or in the operators' clothing, it's hard to bring it out to use.
- Using the phonetic alphabet and numbers is not a very effective way to send exact information
- The schedule needs to be recalculated by hand when changes occur.

## Problem Scenario 2: Ability to find stored goods

Setting: Storehouse, near Umeå airport.

**Persons:** Kenneth, 28 years, truck operator  
Willy, 42 years, storehouse worker  
John, 36 years, assistant transport leader

**Synopsis:** Kenneth arrives to a large storehouse near Umeå airport. He has big trouble finding the right pallets to pick up. When he finally finds them, one is damaged. This must be reported to his superiors.

**Plot:** At 19:02, Kenneth is driving his truck in to the Flight Goods Terminal area near Umeå airport. He backs up and jumps out of the cab. He enters the entry code and walks in to the big storehouse.

**Willy:** - Hi there, what are you looking for, son?

**Kenneth:** - Hi, I'm looking for...(reaches for the consignment note in his leg pocket)...wait a minute, it's gone! It must be back in the cab. Wait here!!

Kenneth rushes back to the cab and finds the note on the floor. He runs back to the storehouse worker, who has walked away to move some pallets.

**Kenneth:** - Now I've got it! Let's see now... I want to find these five pallets with office equipment for the Office Shop. (He shows the notes to Willy who scratches his head).

**Willy:** - Well, this might be a problem. We're rebuilding a part of this storehouse, so some of the goods have been moved around since it arrived. You'll have to find it yourself; I'm up to my ears in work right now. We're always understaffed during nights at this place (sigh).

Kenneth walks around for a long time. Finally he finds the five pallets in a distant corner of the storehouse. When he examines the pallets, he sees that one of them is damaged. He picks up his telephone and phones back to the Transport Management Office to report.

**John:** - PG:s Trucks, Transport Management Office, John speaking.

**Kenneth:** - Hi, it's Kenneth here. I'm standing in the Flight Goods Terminal storehouse with a damaged cargo. Could you take the report now?

**John:** - Hi, Kenneth. Yes, it's OK for me. Go on?

**Kenneth:** - The consignment note number is 7-0-8...

**John:** - "7-0-8"

**Kenneth:** - 6-9-3...

**John:** - "6-9-3"

**Kenneth:** - 3-3-2...

**John:** - "3-3-2"

**Kenneth:** - Dash 7...

**John:** - "dash 7"

**Kenneth:** - OK, repeat that.

**John:** - "708 693 332 - 7"

**Kenneth:** - That's correct. The damage is on pallets number 3. One of its corners has been squeezed in so one of the chairs has been totally demolished.

**John:** - OK, what is its placement in the storehouse?

**Kenneth:** - Well, I think...(looks around)...yes, it's in area 9G. I'm taking the other four pallets with me out of here.

**John:** - OK, could you mark the damaged pallet with Damaged Goods Tape?

**Kenneth:** - Of course, no problem. See you.

**John:** - Bye.

Kenneth takes the four undamaged pallets to his truck, gets the note signed by Willy, marks the damaged pallet with tape and drives out from the storehouse area.

End of scenario.

## Problems analysis:

- How can the operator find the right goods in short time
- How to find out if and how the goods are damaged (and when it was damaged).

## Problem Scenario 3: Get confirmation of delivery

Setting: Inside cab, by Haga Lives, Umeå.

**Persons:** Kenneth, 28 years, truck operator  
Tina, 38 years, Shop manager  
Steve, 21 years, Shop assistant

**Synopsis:** Kenneth arrives to the customer. He enters the code and unloads the goods. He meets the customer and gets confirmation of the delivery.

**Plot:** At 13:43, Kenneth is driving his truck to Haga Livs in Umeå. He phones to the shop and asks for the entry code, which he knows is changed every second week.

**Tina:** - Haga Livs, Tina!

**Kenneth:** - Hi, this is Kenneth from PG:s.  
What's the new code at the rear gate?

**Tina:** - 6748

**Kenneth:** - 6748. Could you come and confirm?

**Tina:** - I don't think so, but Steve is usually downstairs. I'm sure you'll find him.  
If you've got time you can come up and get a cup of coffee.

**Kenneth:** - Yeah, that would be nice, thanks.  
See you in fifteen minutes!

**Tina:** - Bye.

Kenneth arrives and starts to unload the goods. He pulls out the first pallet, enters the code and places it inside the storeroom. He looks around to find Steve. He spots him in the storeroom.

**Kenneth:** - Hey you. Can you come here and confirm this consignment note?

**Steve:** -Yep. (Steve signs)- There you go!

**Kenneth:** OK, thanks.

Kennet walks back to the truck cab to park the truck. Then he walks up to Tina for a cup of coffee with her and the rest of shop staff. After that he continues his delivery route.

End of scenario

## Problems analysis:

- The operator has to phone the customer to get the new entrance code every time it is changed.
- The operator must dial the code every time he wants to pass through the back entrance.
- Even well known customers must sign the consignment note with their hand written signature.

# 4. Initial Design

After the problem definition phase, the idea generation phases started in November 1999.

## 4.1. Two Technical Horizons

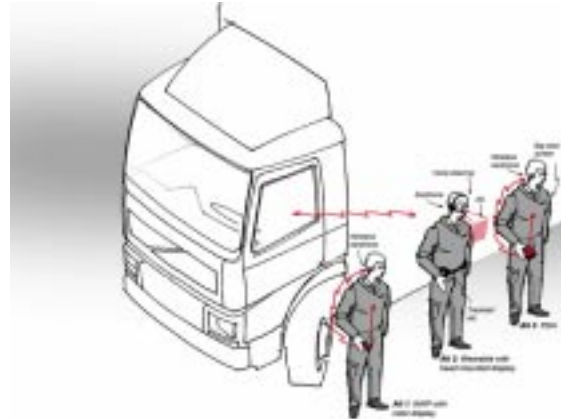
To be both visionary and technical realistic we focused in the first design sketching process on two technical horizons: near market technology and technology under development.

In the following sections (4.1.1-4.1.2) a few of the ideas we came up with during our first sketch phase are shown.

### 4.1.1. Near Market Technology

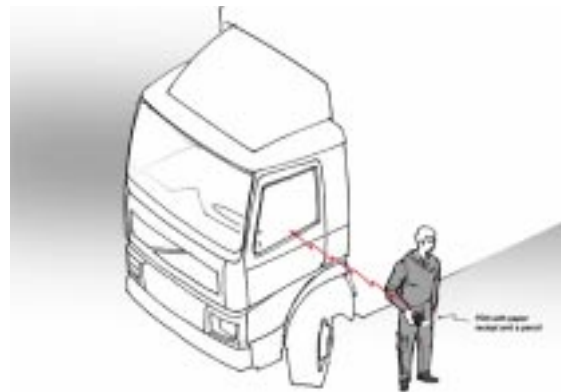
Get information of new assignments

For this situation, techniques as Wireless Application Protocol (WAP), GPRS, UMTS, wearable computer with a Head Worn Display<sup>7</sup> (HWD), or an ordinary Personal Digital Assistant (PDA) with a short-range radio connection to the cab could be useful. To keep down the number of wires and cables all of these concepts Bluetooth technology has been deployed for wireless data transfer within the devices worn by the operator.



#### Confirmation of delivery

A PDA with short-range radio connection to the cab with built in paper receipt printer for the consignee. This is a typical single-purpose device for signing the delivery.



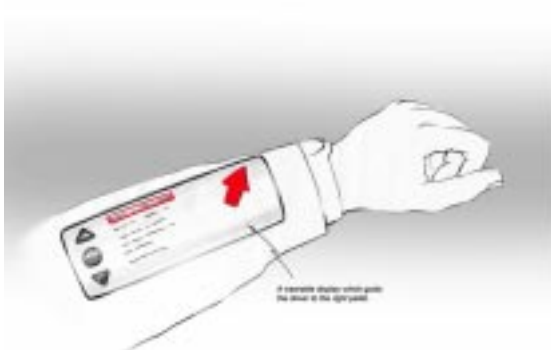
#### Finding stored goods

Here a PDA, which guides the operator (like a compass) to the right pallet. In this case a tracking system has to be deployed.

<sup>7</sup> Is also known as Head Mounted Design (HMD) or Display glasses.



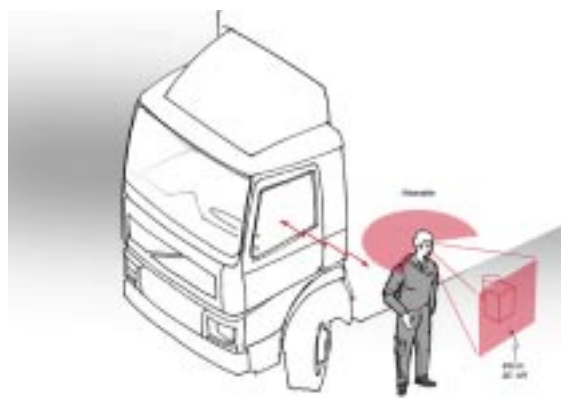
In this case a wearable display worn on the arm with the same functions as the concept above.



#### 4.1.2. Technology under Development

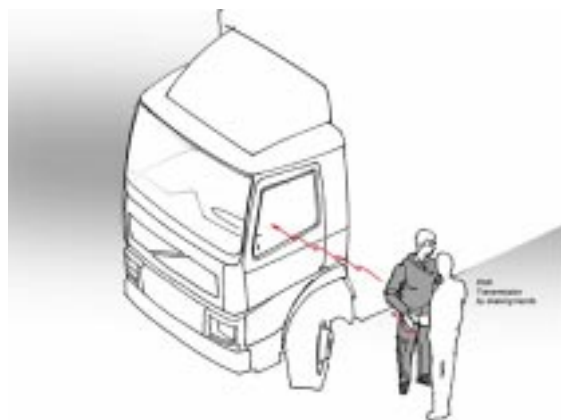
Get information of new assignments

A wearable computer with 3D sound system supported graphical information in Augmented Reality<sup>8</sup> (AR).



Get confirmation of delivery

Personal Area Network (PAN) with transmission by shaking hands. The PAN technology is small, ultra-low currents that are carrying small amounts of information via the users own skin. This is utilised by attaching a small device to the users skin (smaller than an ordinary pager). In this scenario all consignees need to have this device on them.

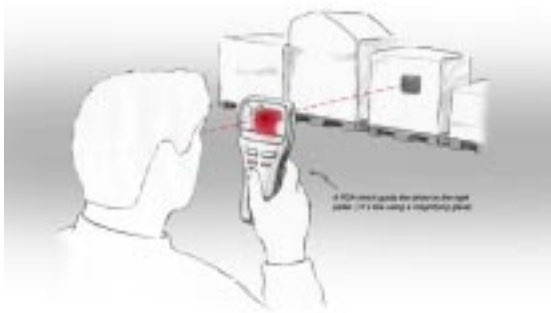


Touch screen area for fingerprint as confirmation. The biosensor technology has come a long way and a system like this is definitely plausible to make. A problem in this concept is that all consignees' fingerprints have to be registered in a database before it would work.



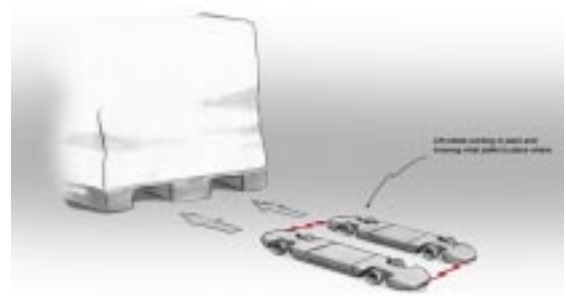
### Finding stored goods

A magnifying glass shaped PDA with a look-through display, which guides the operator to the right pallet. This concept is supposed to use a kind of AR system and a fast tracking system that updates the users position and the goods' position in real time.



One of the most Sci-Fi ideas that came up was to use a couple of lift robots that are working in symbiotic pairs knowing what pallet to place where. The operator just walks in to the storehouse, whist-

les on his faithful pair of robots which runs up next to him. He says, "get my goods" to them and they runs off like a pair of trained sheepdogs and fetches the goods for him. They lift it up and bring it into the truck. No more crushed feet or aching backs...



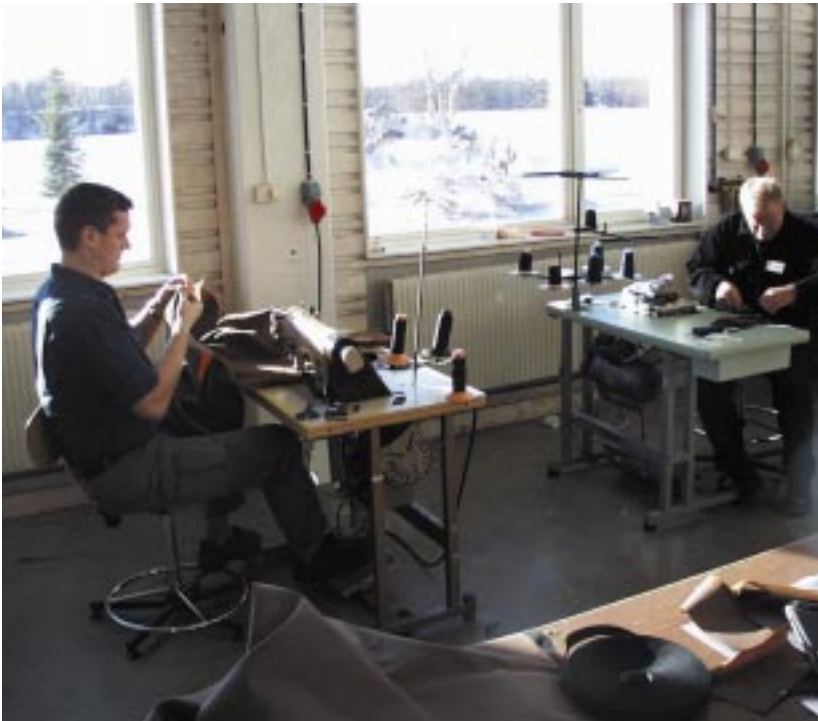
<sup>8</sup> Augmented Reality is related to Virtual Reality but has one important difference. Instead of viewing a complete computer generated representation of a virtual world the data is super imposed onto the real world.

# 5. Workshop

The 10–11<sup>th</sup> of February 2000 a workshop was held at the institute of Design. Participants were representatives from Volvo Trucks, Nokia, Snickers Europe and the Institute of Design. The purpose of the workshop was to participate in the creative phase of the project and to discuss new ideas. The brainstorming resulted in a number of concept ideas that were presented in simple sketch models. Some of the conclusions of the workshop were that there are problems today with extensive paper work and a noisy environment. The truck operator is working with both hands, which makes it harder to handle papers or telephone at the same time. The requirements of the products will be both visual and audio information; true hands free and the

truck itself should have some kind of intelligence to support the operator. The solutions were that an electronic consignment note and smart cargo should replace the paper work of today. Voice controlled system would be useful.

There were also discussions of hardware. The conclusions were that the problems that have to be solved are the battery capacity and how to arrange cables. Also the social aspects have to be considered to make the products fit into the working environment. Another problem to discuss was when products will be built in into clothing. It will require summer/winter equipment. The solutions were to make a Cap-mounted-display with camera and earphone, or a PDA with monocle display.



PH Magnusson, Snickers Europe and Christer Mellgren, MellTex are sewing textile models.

Stina Sjöström, Myra Design and Petra Engström, Snickers Europe are discussing two ideas that originated from the workshop. Stina is wearing the audio collar round her neck and a soft PDA round her right wrist.



The workshop was organised so that the whole group was presented to a problem. The group was then split into three groups that tried to come up with solutions in 2-3 hours. Here Arto Lammintaus, Nokia, Stina Sjöström, Myra Design, Christer Mellgren, MellTex (facing away from the camera) and Bengt Münter, Volvo Trucks are engaged in a brainstorm session.

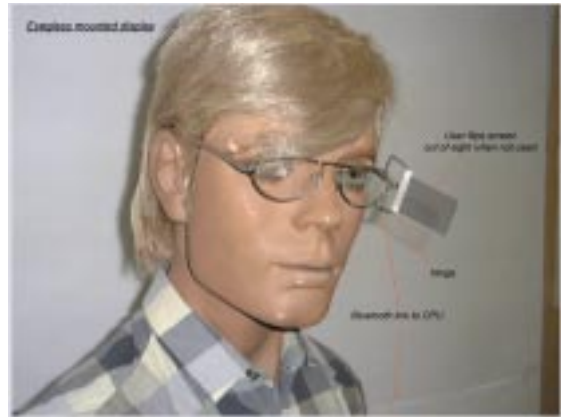


Most of the ideas from the brainstorm sessions were presented to the other groups as overhead slides or short role-plays.





In some cases, physical models were built to illustrate the overall idea. In this case an ordinary baseball cap was converted into a hi-tech “Computer Cap” with a screen, camera and speakers supported via a solar panel and a Bluetooth link.



An eyeglass display that can be easily flipped out when it's not in use.



Here is a proposal for a monacle PDA with a magnetic screen holder worn round the neck.



A notation tool with built-in gyro that remembers what is written, regardless what kind of surface has been used.

# 6. User participation

Five operators working at ICA Haakon AB in Umeå participated in the user tests. They were all Swedish men between 27–55 years of age and had working experiences of haulage or goods handling between 8–25 years.

To get to know the group better we let them fill in an initial explorative questionnaire where we asked questions about their working environment in general and their information needs in particular. They were also asked to prioritise among those needs. All of this gave us useful information for the latter part of the project.

The user test sessions were held at totally four occasions during January–April 2000. Each time the group was split into three small groups of 1–2 persons in each group.

The first meeting in the beginning of the project the discussion was about the focusing areas of the project and new technical possibilities that could be used in future products. The second and third meetings in the middle of the project the groups

tested and commented different sketch models and different types of interfaces. The models and interfaces with varying level of “roughness”. Some of them just simple lines and symbols drawn by hand and other more realistic mock-ups or interfaces made with computer.



An example of what different types of sketches and models of the graphical user interface that was used during our test sessions.

At the fourth and last meeting the groups tested an interactive version of an interface.

These test results were the foundation to the final design of the products.



Test group members Per Bernhardsson and Mikael Löfgren are testing our low fidelity prototypes.

# 7. Interaction Analysis

## 7.1. Input

As described in 3.1 User studies, the working environment is very tough and the truck operator is doing a lot of physical working tasks. For example, he pulls the pallet carrier with goods, lifts packages, climb in and out of the cab. He is often busy with both hands and is often using gloves. That means that a lot of situations do not admit system controlling by a keyboard. But of course a few buttons should be possible to handle in some situations. During working tasks when both hands are occupied the best type of controlling of a system or a device is by speech.

## 7.2. Output

Suitable output is sometimes visual in text or pictures on a display. Sometimes sound in alarm or sound as indications of some functions is better. It could also be as synthetic speech messages or a combination of both sound and visual information. All these outputs are depending on what the operator's task is at the moment and how the working environment affects the situation.

## 7.3 Functions

The main functions that this project is focused on are:

- **Telephone – how to make speech communication**

The telephone communication is today very important. The problem is that the way it is used is not suitable for the working situations.

- **Camera - in what way picture information could complement the other information and how a camera should be arranged**

The information of a digital picture could be very useful in some cases, for describing a problem, when goods are damaged or what a place looks like.

- **Database terminal - how it should be arranged and be handled**

- **Audio entertainment - how it should be arranged and be handled**

- **Personal alarm**

# 8. Final designs

## 8.1. Three Concepts

The tests, interviews and the brainstorm ideas resulted in three concepts, which represent the two technical horizons that the project focuses on. The first one, a device mounted on a cap, is more of a future vision and represents the “Technology under development” horizon. The other two concepts, a collar device and an arm and handheld device, represent the “Near market technology” horizon.

### 8.1.1. Cap Mounted Display

A way of making a product more socially accepted is to integrate it into the normal clothing as much as possible. According to the test group a lot of the operators wear caps, or if they do not would accept to put on every time they jump out of the cab. That means that the cap itself could work as a carrier of small technical components. This concept consists of an ordinary cap that carries a monocular display, a camera, microphone and earphones. It is supported with solar panel and wireless connected to the computer in the cab.



The Cap Mounted Display is adjustable and detachable from the cap, which makes it very flexible to use, even if the user changes the cap often. The idea of making it monocular originates from the social need to see the other person in the eye when having a conversation.

The graphical interface is visualized in a way that it appears in front of the operator. The interaction of the interface in the Cap Device is only by speech. A special button to activate the system for giving commands is also required. This button could for example be placed at the belt or at the wrist or anywhere that the operator would feel it comfortable.

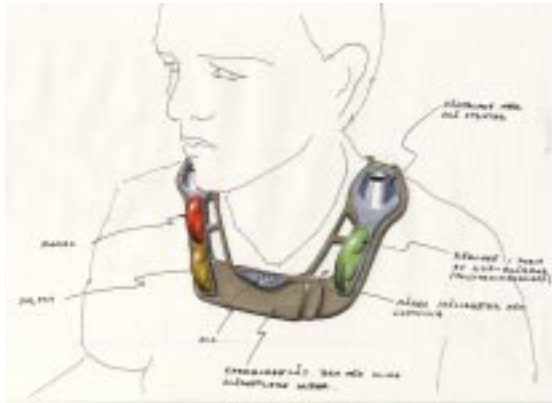


By using a mirror and lens system, the user experiences that the GUI is “hanging” in the air 60 – 80 cm away.

### 8.1.2. Audio Collar Device

This product is replacing the mobile telephone. The Collar works through speech control. When the button on the left part of the device is pressed with the right hand thumb the system is activated and open for speech commands. The intention was to make the sound from the speakers pointed to the users ears. If you stand close to the user you should not clearly hear everything from an ongoing telephone call between the user and someone else. Therefore the speakers are placed where the user easiest could hear the sound. With this arrangement the user can make a call and at the same time notice things happening around him and does not need to be disturbed by wearing phones in the ears the whole day long.

The Collar device could also work as a radio. When the operator is sitting in the cab he might be listening to the radio or a CD. When he jumps out of the cab the collar automatically takes over the radio station or CD track. If someone calls it automatically changes to phone mode.



An early sketch of the collar device with the controls arranged as red, orange and green wedge-shaped slices, which the user squeezes when to change channel, volume and telephone.



The final design is a hard collar with double-jointed speaker modules.

Here is another way of arranging the device. In this set-up the device is connected to the jacket. When the jacket is taken off, the collar is automatically opened with the Velcro strip. This is handy in the winter when the jacket often is taken off and put on several times during the working day.

### 8.1.3. Arm- and Handheld Device

This type of PDA is one of the most typical of wearable concepts today. Studies have shown that a small computer worn on forearm or thigh has the best values in unobtrusiveness and accessibility (Gemperle et al). The same study came up with guidelines saying that wrapping around the body is more comfortable than using single point fastening systems such as clips or shoulder straps. Low weight and that the device should not create, focus or trap heat are other important issues when designing wearable components.

To make our system as flexible as possible we made the PDA in two versions (same top piece, different lower parts): arm mounted and handheld worn in pocket. The pocket model also incorporated a storage volume for a pen.

The screen is touching sensitive. The only other interaction hardware is a button for activation of the speech input function.





## 8.2. Final System Design

In the beginning of the project a lot of effort was put on determining whether the system should have one Multifunctional Device that is integrated into the users' PDA or if all functions should be divided into many simple devices, like Donald Normans' Information Appliances.

The following Pros' and Cons' were identified:

### One Multifunctional Device:

- + Easy to synchronize
- + Easy to protect against external force and wearing
- + Lower manufacturing costs with one casing
- + Available technology today
- Not user-friendly interface with many modes
- Increased vulnerability for internal system malfunction
- Demands high bandwidth
- Compromises in hardware design is inevitable
- Dependency on one power source

### Many Information Appliances:

- + Low bandwidth
- + Less vulnerability for internal system malfunction
- + User-friendly interface for new users
- + Every device is optimised for its function
- Many devices that can broke down
- Increased risk of magnetic filed radiation exposure
- Increased risk of disturbance with other devices nearby
- Expensive with designated hardware and casings

After discussions within the project group, we decided to use both systems in our designs. The arm-

and handheld PDA is a typical multifunctional device and so is also the Cap Mounted Display.

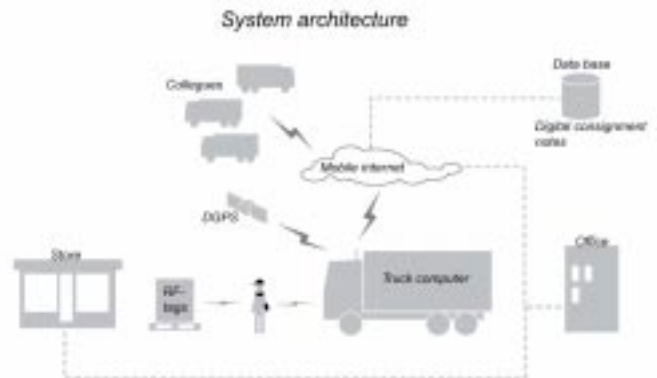
The Audio Collar device is a typical Information Appliance, though it has more than one function.

## System layout

The system has the same layout independent of which kind of devices are used. The truck is the main hub in this set-up with the main transmitter mounted in the cab.

The system is constantly online with mobile Internet, which connects the truck operator with databases, the office, colleagues and the customers.

All communication has a high level of security (e.g. encryption, firewalls etc).



## 8.3. Final Graphical User Interface Design

As mentioned earlier in this report we decided fairly early to make one generic Graphical User Interface for both the Cap and the PDA. The functionality aspect was to make it controllable with touch screen and voice control.

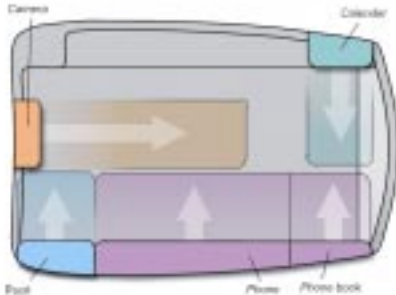
The general idea about the interface was to have three layers:

Layer 1: The basic function (schedule and goods) lying permanently in the background.

Layer 2: The additional functions (Camera, Calendar, Truck tech info, Phone and Phone book) were

placed on tabs, which slide out when the function is activated. All of the functions can be activated without any other function tab is covered.

Layer 3: Extra Pop-ups for messages, system dialogue and searching goods is always on top.



The schedule main screen has what can be described as an expert user GUI. All extra information is taken away so that no visual noise can compete with the presented information. In the screen below the following can be read out:

- The time is 11:42
- The “collections” mode is activated
- 5 pallets from ICA-Diamanten and 4 pallets from Svenssons Livs has been collected
- Right now 3 pallets from Bengtssons Lathandel is being collected and is put into the truck and the trailer, “L” = Lastbil (“truck” in Swedish) “S” = Släpvagn (“trailer” in Swedish)
- The 4 pallets from Svenssons is temperature sensitive (Celsius sign)
- Something on the 2 pallets from ICA-Affären are classified as dangerous goods class 5.2
- The total weight of the truck are right now 16.216kg
- A phone call from Bosse is progressing



Below, a picture that simulates how the monocular Cap Mounted Display would look like when implemented.



## 8.4. Final scenarios

To illustrate the resulting solutions we have recycled the problem scenarios from chapter 3 and updated them with our new devices etc. Focus for this project where the possible timesavings. We have visualised the time factor by putting in clocks and time codes in our scenario sketches:



These clocks are visible on all of the following scenario sketches, made by Johan Borgström.

## Scenario 1: Kenneth confirms a new assignment

One Wednesday in September, Kenneth is rolling out racks from his truck's cargo space at Kranvattnet's country shop, 55 km west of Umeå. The wheels clatter and make a lot of noise when they roll over floor plates and aluminium plank.



In his Cap Mounted Display (CMD), Kenneth notices that Bill is calling.



He decides to take the call and activates the phone function by pressing the Speech button when he says "Answer".





**Kenneth:** -Kenneth speaking.

**Bill:** - Hello, it's Bill.

**Kenneth:** - Hi! What's up?

**Bill:** - We've got a new order that's pretty urgent.

**Kenneth:** - OK?

**Bill:** - Well, it's nine racks in return from ICA in Hissjö. They want them picked up before...eh... 14.30 today. I thought you could take it when you're driving back in the afternoon?



**Kenneth:** - Hmm, well... I've got to check my schedule for today first.

**Bill:** - OK. I'll wait...



Kenneth touches the Speech button and says, "Schedule today" to the computer. Because the button is disabling the telephone microphone, Bill can't hear Kenneth's commands to the computer. The computer answers directly by displaying the scheduled deliveries and collections for tomorrow.

**Kenneth:** - ...It looks all right to me. I'll have to leave a bit earlier from Vindeln, but it's OK. By the way, I've never picked up stuff from Hissjö before. How does it look like?

**Bill:** - No problems, I'll include all the necessary details with the collection files. While they are talking, Bill sends the files to Kenneth, which schedule simultaneously updates with a new collection at 14.00 in Hissjö.

**Bill:** - Perfect! (pause) OK...that's it, then...

**Kenneth:** - OK. Bye.

**Bill:** - Bye.



Kenneth hangs up by pressing the Speech button and saying "Hang up". Then he continues unloading the truck.

*End of scenario.*

Estimated time saving 8 minutes (35 %).

## Scenario 2: John finds goods



John arrives to a large storehouse near Umeå airport, where he has some goods to pick up.



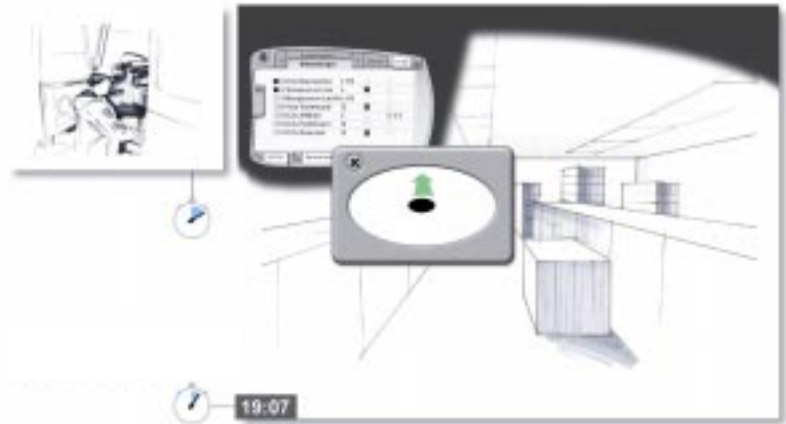
When he has backed up to the door, it automatically checks his ID, opens up and he walks in.



He checks in his Cap Mounted Display (CMD) what goods he will pick up: five pallets of office equipment for the Office Shop. At this time he also gets a notification from the database that one of the pallets is damaged<sup>9</sup>.

<sup>9</sup> All pallets containing fragile goods are equipped with sensors, which indicates if the goods or the wrapping is damaged. This information, together with position, time, date and transporter ID is logged in the imaginary International Consignment Database (ICD).

He looks around, but he can't see the goods from where he's standing. He presses the Speech button and says "Search" to the computer. The CMD guides him to the goods.



When he arrives to the goods, he directly goes to the damaged pallet. He activates the camera by pressing the Speech button and saying, "Take picture". The camera function is instantly activated and a picture is taken.



He records a speech note about the damage. The picture and the note are automatically uploaded to the database together with location coordinates. All this information is linked to the electronic consignment note.





John loads the four undamaged pallets to his truck and they are automatically registered as loaded when the pallets pass the truck's back doors.



He marks the damaged pallet with signal tape...



...and drives away from the flight goods terminal

*End of scenario.*  
Estimated time saving 25 min (58%).

### Scenario 3: Bill gets consignee signature

Kenneth is driving towards Haga Livs. Because the store has joined the eCnote network, all entrance code information is automatically stored with Kenneth's identity at the database.



He doesn't have to call up the store to get information; he can focus on the driving and traffic instead.



He arrives to the store and unloads the first pallet from his truck...





When he gets close to the door, it opens automatically because the door knows that Kenneth is trusted to enter the shop's back door.



Also, because Haga Livs is a good customer since way back, no written confirmation is needed. Instead the goods is simply registered in the database as delivered when it has passed through the door.



After loading all the pallets, Kenneth walks in to the staff room for a cup of coffee. After that he drives on to the next customer on the route.

*End of scenario.*

Estimated time saving 5 min (8 %) <sup>10</sup>.

<sup>10</sup> This scenario did not show the same amount of time saving as the previous two scenarios, mostly because the operator takes care of most of these communication tasks during the drive towards the consignee. In this scenario that kind of speech communication is not necessary and the operator can concentrate on the traffic instead. This results in increased traffic safety, rather than pure timesavings.

# 9. Prototypes

## 9.1. Cap Mounted Display (CMD)

MSc student Fredrik Nilbrink at the Department of Applied Physics and Electronics worked with the Cap Mounted Display. His work originated from a Xybernaut Wearable Computer, which he modified with a W-LAN to get access to Internet.

He took apart a pair of Sony Glasstron VGA-glasses to get the monocular Head Up Display we wanted for this project. On top of the cap a web camera was mounted.



The SONY Glasstron prototype.



The physical model showing the flexible fittings and the adjustable earplugs.

The network was designed by using a 10 Base radio link from RadioLAN, which allowed the truck operator to move freely within a restricted area<sup>11</sup>. In this case the area was either within 500 meters from the truck or in a large storehouse with a wireless LAN itself.

Bandwidth should not be a problem in this kind of network. The tested system transmits 2Mb/s and new IEEE standards for wireless LANs suggests 11Mb/s.

Two systems for voice recognition were tested on the Wearable platform: Freespeech from Philips and ViaVoice from IBM. The latter had more functions but Freespeech was more user friendly and was more tolerant towards European accents.

## 9.2. Audio Collar Device (ACD)

MSc students Lena Ahlgren and Urban Lehto investigated what kind of small loudspeaker and their positioning in terms of sound quality and environmental noise suppression on the ACD within the speech range 300-3400 Hz.

Measuring different speaker elements and placement made the most part of the research.

To create a directed sound transmission a variety of loudspeaker boxes were designed.

After a series of tests on a test dummy, the best position for the speaker elements was on the upper front chest region between the platysma and greater pectoralis muscles.

<sup>11</sup> Roaming



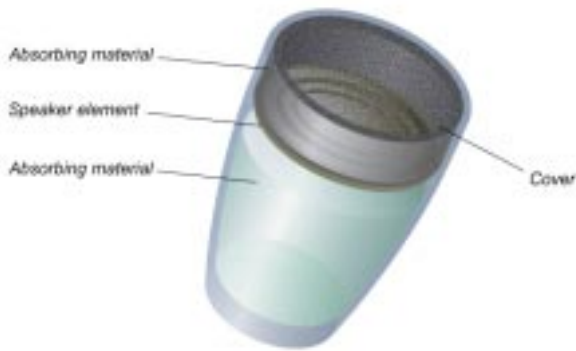
*The optimal  
speaker placement*

The speaker box had the following requirements to fulfil:

- Achieve a flatter frequency curve
- Subdue the higher frequencies
- Enforce the lower frequencies
- Obtain directed sound towards the ear
- Subdue the surrounding ambient noise

After tests of different principal designs with altered relative positions the following design was chosen:

By using absorbing materials in the box and placing the speaker element inwards the box  $\frac{1}{4} - \frac{1}{3}$  of the distance, superfluous sound distribution in space was substantially decreased.



### 9.3. Arm- and Handheld Display (AHD)

MSc student Marcus Lindström worked with the GoodsFinder function for the AHD<sup>12</sup>. The idea was to have a handheld device that gives the truck operator navigational information of direction towards the goods he/she is looking for. The goods position is tracked with Radio Frequency Tags placed in the floor of the storehouse.

The prototype contained of a handheld Goods-Compass connected to a server. The server was positioning the compass and gave feedback on the goods position by lightening an array of LEDs. The communication between server and Goods-Compass was by wire (RS232) but can easily be transformed to wireless communication.

Test showed that the system was able to distinguish between a multitude of packages and give information according to an in advance prepared list on the server.

To get good transmission between the GoodsCompass and the RFTags in the floor, an antenna was incorporated in a shoe.



The hand worn Package Compass, which is connected to the server. The cable in this case shall be replaced by a wireless link.



The packages placement is registered by RF-tags under the carpet



The RF-tags used in this prototype is made of the same material as ordinary credit cards



The handheld unit shows the way to the selected package with LEDs

(pictures from the enclosed video goods.mov)

<sup>12</sup> The GoodsFinder was later also incorporated in the Cap Mounted Display

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<http://www.akeri.se> Svenska Åkeriförbundet (Swedish Hauliers Association) (May 2001)

<http://www.bluetooth.com> The official website on Bluetooth technology (May 2001)

<http://www.notisum.se/rnp/sls/lag/19820923.htm> Förordning (1982:923) om transport av farligt gods (Swedish regulations on transporting dangerous goods) (March 2000)

# 11. Acknowledgements

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Marcus Lindström, Msc student (Goods Finder)  
Paul Sandström, Msc student  
(Cap Mounted Device)  
Lena Ahlgren, Msc student (Audio Collar)  
Urban Lehto, Msc student (Audio Collar)

## Workshop Participants in Umeå February 10–11<sup>th</sup> 2000:

Bengt Münster, *Volvo Trucks, Gothenburg*  
Thor Persson, *Volvo Trucks, Umeå*  
Roger Sandgren, *Volvo Trucks, Umeå*  
Claes-Rune Arp, *Volvo Trucks, Gothenburg*

Panu Johansson, *Nokia, Tampere*  
Arto Lammintausta, *Nokia, Tampere*  
Per-Henrik Magnusson, *Snickers Europe,  
Sollentuna*  
Petra Engström, *Snickers Europe, Sollentuna*  
Christer Mellgren, *MellTex, Stockholm*  
Bengt Palmgren, *Institute of Design, Umeå*  
Tapio Alakörkkö, *Institute of Design, Umeå*  
Niklas Andersson (workshop organiser),  
*Institute of Design, Umeå*  
Lars Johansson (workshop organiser),  
*Institute of Design, Umeå*  
Mikael Thelin, *Institute of Design, Umeå*  
Stina Sjöström-Juhlin, *Myra Industriell Design,  
Stockholm*

## Other cooperation partners:

Inge Nilsson, Nexus Technology AB, Umeå  
Nils-Erik Gustafsson, Ericsson Utvecklings AB,  
Stockholm

## User group from ICA-Haakon, Umeå:

Anders Högdahl, Truck Operator  
Inge Comstedt, Truck Operator  
Kjell-Arne Thiger, Truck Operator  
Mikael Löfgren, Truck Operator  
Per Bernhardsson, Truck Operator







**DESIGNHÖGSKOLAN** vid Umeå universitet är en av landets fyra utbildningar av industridesigner på högskolenivå i Sverige. Utbildningen omfattar fem års studier. Efter en inledande basutbildning på tre år kan de studerande specialisera sig inom tre olika områden.

Specialiseringarna utgörs av två-åriga magisterprogram som genomförs på engelska och är öppna även för utländska studerande. Var fjärde studerande på Designhögskolan är utländsk. Totalt finns det ca 80 studerande på Designhögskolan.

De tre magisterprogrammen är Transportation Design, Advanced Product Design och Interaction Design.

Unikt för utbildningen på Designhögskolan är det nära samarbetet med industri och näringsliv. Samtliga övningsprojekt och examensarbeten utförs i samarbete med industriföretag. Sedan starten 1989 och fram till 2001 har projekt utförts med ett åttiotal företag. Saab Automobile, Volvo Lastvagnar, Volvo Personvagnar, Electrolux, Ericsson, Telia Research, m fl hör till dem som vi har återkommande samarbete med.

1997 inleddes en verksamhet med tillämpad forskning genom ett treårigt forskningsprogram, finansierat av Volvo Lastvagnar i Göteborg. Senare har ytterligare ett forskningsprogram startats. Flera forskningsprojekt genomförs i samarbete med andra institutioner vid Umeå universitet.



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