CHALMERS

Additional equipment to nurses' communication system

Master of Science Thesis in the Master Degree Program, Industrial Design Engineering

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Abstract

This Master Thesis was executed at the department of Product- and Production Development at Chalmers University of Technology by Linnea Jading and Oskar Lindh. The project was conducted in collaboration with Ascom Wireless solution, partly at their office in Gothenburg.

The project aimed to create an accessory to a communication healthcare product, currently under development at the collaboration company. The new product will particularly target communication among nurses, why nurses also was the target group for this project.

The final result is a small handheld device called MEMco, consisting of a set of functions which are enabled through the use of the device and a mobile application in the company's new communication product. MEMco aims to minimise the negative consequences of interruptions that nurses experience every day, by providing memory assistance for task that otherwise easily are forgotten. The device is a mixture of a voice recorder and a timer, with the availability to categorise the recordings by choosing from four different symbols.

An initial theoretical study was carried out, providing the project group useful and important information about the healthcare section. Further, a thorough field study was planned and conducted, involving six wards at five different hospitals in the Västra Götaland Region. All gathered information was analysed and divided into different areas. By sorting out problems and issues that were relevant for the thesis, two separate tracks for idea generation were identified; memory assistance and patients' perspective.

The idea generation involved focus groups with nurses, workshops with students and employees at Ascom and also individual brainstorming. Focusing on how to facilitate memory work among nurses and to improve the patient experience, a high number of ideas emerged. The ideas were combined into concepts, which were presented for the company and the supervisor. By evaluating the ideas together with the company, it was chosen to proceed with the field of memory assistance. Through merging two concepts one final concept was created. As a part of the concept, both a physical product and a mobile application were designed and evaluated, according to physical and cognitive ergonomics. The evaluation was carried through together with nurses, whilst technology experts within the company provided input upon the reliability of the design. Further, the final evaluation verified that the target group was pleased with the result and that the product would solve an existing problem.

Preface

This report is the documentation of a Master Thesis project carried out by Linnea Jading and Oskar Lindh during the spring of 2013. The Master Thesis project counts as the final examination of the Industrial Design Engineering program at Chalmers University of Technology. The project was conducted in collaboration with Ascom Wireless Solution, and aimed to design an accessory to a communication product targing the Healthcare sector and being under development by the company. The report chronologically describes the plan, process and final result of the project.

We want to thank everyone who have been involved and engaged in our project, with a special thanks to all nurses who have participated in interviews, observations, surveys and focus groups. We would especially like to mention Anna, Erika and Hannah for their recurrent involvement.

Furthermore we want to thank Ascom who gave us the possibility to sit in-house, and in particular our supervisors; Karin Eklund and Linnea Fogelmark for all their invaluable time and shared experience. Also we would like to thank Jan Korpegård for his counseling and Ulf Bergh, who set up the prototype printing at Ascom.

At last we would like to thank our supervisor and examiner at Chalmers, Oskar Rexfelt, who has helped us all the way through the project.

Linnea Jading and Oskar Lindh

Gothenburg, 2013

Contents

1. Introduction

1.1 Background

This Master Thesis has been executed in cooperation with the client Ascom Wireless Solutions within the field of mission-critical communication. Ascom (below referred to as the company) designs, manufactures and sells communication equipment developed to fulfil the tough requirements of professional users working in contexts where efficient communication is of highest importance. The company's biggest customer group is hospitals, and the product range mainly includes mobile phones, pagers, different kinds of alarms, patient communication devices and systems for the products to be integrated with each other as well as with other companies' products.

At the point-in-time when this project was executed, the company was simultaneously looking to design a new smartphone concept which would consist of both a hardware- and a software system. The new concept was supposed to target the healthcare sector and be designed specifically to fulfil the various needs of nurses in hospital wards. Since it was under development, the company wanted to look into ways of increasing the added value of the smartphone concept for the user, through development of additional equipment connected to it.

The smartphone concept's main user, the nurse, has a demanding job with important decisions to be taken daily that have direct consequences for the patients' health and well-being. Nurses operate to tight time schedules, while communicating as well as cooperating with many different people and functions in their everyday work such as other nurses, doctors, lab personnel, patients and their families. Other important tasks related to communication that are performed by nurses are responding to different kinds of alarms, to give medication, to do patient documentation and to operate medical devices and machines. It can be a very social and engaging job but also stressful and exhausting since a nurse has to maintain their focus throughout the whole shift.

1.2 Purpose

The purpose of the project was to examine the communication difficulties that arise in a healthcare context, and how the work situation of nurses could be improved. A solution aimed to assist in solving the problems was also to be proposed in this project through the development of a design. In this project, "a design" meant either a physical product, a set of complementary products, an interface, a service or a combination of one or several of them. The result was supposed to be an integrated complement to the company's above mentioned smartphone concept and through that add value to the system from a market perspective, a so-called accessory. The design would fulfil the requirements from the client, which was that it should be innovative but still realisable seen to both profit and technical possibilities. Aesthetically, the design should match the company's other products within the segment.

Throughout the project, a purpose was to answer the following research questions.

- What are the most common/important/severe problems that arise for nurses related to communication?

- How can nurses' needs that are related to their mental workload and communication with patients be fulfilled by a design?

- How can the improvement be done in a feasible way as a complement to the company's new smartphone system?

- How well does the design result fulfil the requirements of its' intended users?

1.3 Goals

The goals of the project were the following:

- Fulfil one or several of the main needs identified in the field study of the project

- Develop a design which would be technologically realisable and economically beneficial for the company

- Match the design to the company's product portfolio

- Maximise the durability of the design over time

1.4 Delimitations

The technical requirements and regulatory demands of products aimed for use within the healthcare sector are of hygiene reasons extremely high, and the company uses standardised materials in their existing products. Therforee, if the project would result in a physical product, the selection of materials would only be addressed on a general level in the design, using mainly the company's standardised materials.

The knowledge and expertise of the project group is not primarily within software development. Of this reason a functional mock-up of the interface could possibly be created, but a complete software would not be programmed by the project group.

Since the project aimed to develop a conceptual design requiring some additional specification before being ready for production, the exact cost and price of the product was not to be included as a deliverable.
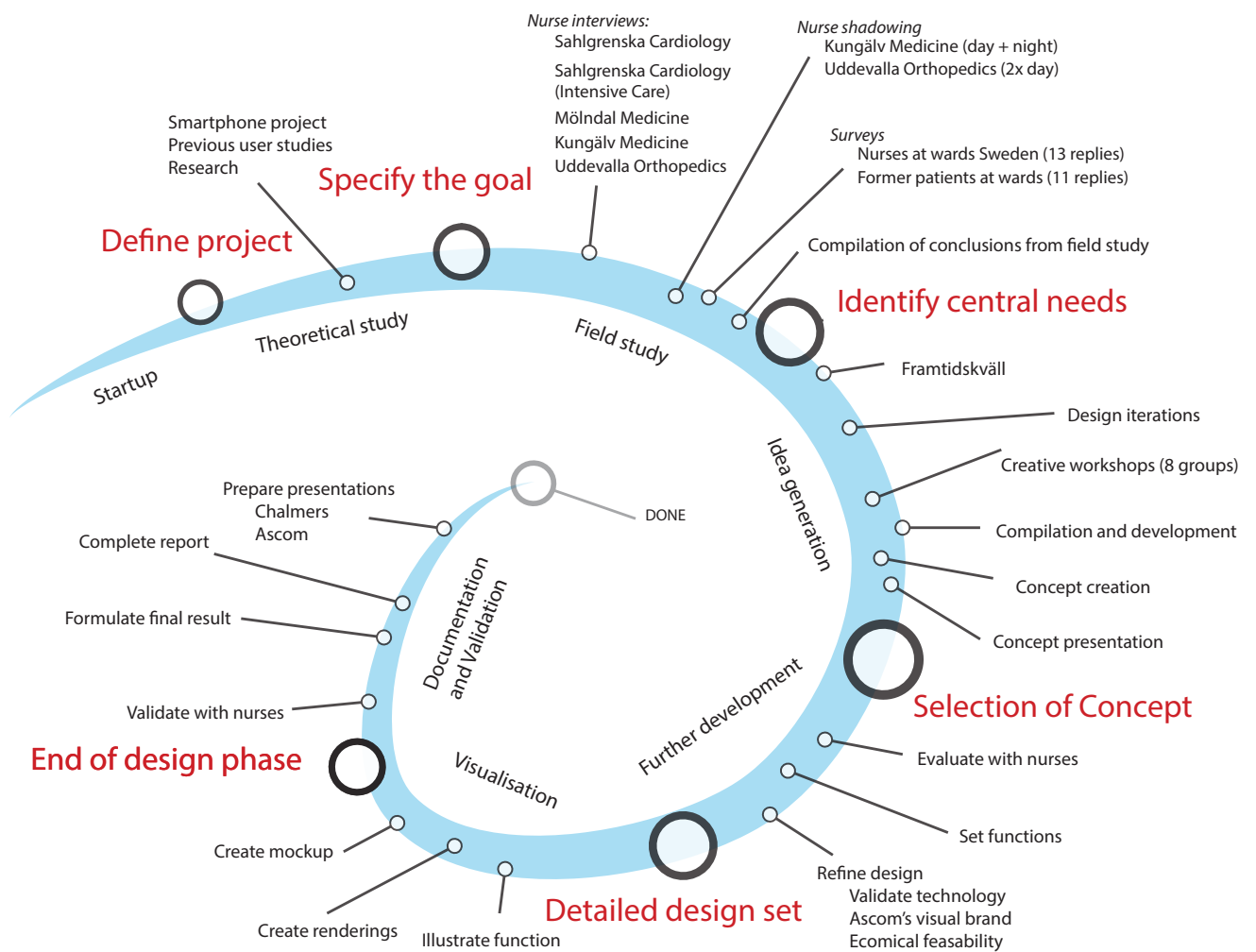
1.5 Priorities

The major focus areas in the project were (In no particular order):

- User benefits; Focus was supposed to be put on this by continuous contact with users (nurses). Problem detection and solutions evaluation was to be done together with them. User test of design solutions would also include actual users and therforee strengthen the outcome from a user benefit perspective.

- Market, profit and technical feasibility; would be assured through interviews and contact with personnel at Ascom, to ensure the commercial viability.

- Innovation and novelty of solution; Different brainstorming methods were supposed to be used to find new possibilities within communication between nurses and patients which was yet unexplored. A comparably high level of innovation was also one of the requirements from the company.

- Environment; by making the final solution as durable (considering function as well as aesthetics) and repairable as possible. Environmental sustainability was also a factor that both the concepts and the final the design were to be evaluated against.

1.6 Process

This master thesis project consisted of the phases seen in picture 1.6, being Start-up, Theoretical study, Field study, Idea Generation, Further development, Visualisation, and Documentation and Validation. The structure of this report mainly follows the project process, with some minor exeptions. The Theoretical study is divided into Chapter 2. Theory and Chapter 3. Prestudy, and the theory chapter has also been fed with additional theoretical input when needed throughout the whole project process. The Idea generation phase is divided into two Chapters, 5. Idea generation and 6. Concept development.

Define project

Specify the goal

Smartphone project
Previous user studies
Research

Startup

Theoretical study

Field study

Nurse interviews:
Sahlgrenska Cardiology
Sahlgrenska Cardiology
(Intensive Care)
Mölndal Medicine
Kungälv Medicine
Uddevalla Orthopedics

Nurse shadowing
Kungälv Medicine (day + night)
Uddevalla Orthopedics (2x day)

Surveys
Nurses at wards Sweden (13 replies)
Former patients at wards (11 replies)

Compilation of conclusions from field study

Identify central needs

Framtidskväll

Design iterations

Creative workshops (8 groups)

Compilation and development

Concept creation

Concept presentation

Idea generation

Selection of Concept

Evaluate with nurses

Set functions

Further development

Refine design
Validate technology
Ascom's visual brand
Ecomical feasability

Detailed design set

Illustrate function

Create renderings

Create mockup

Visualisation

Documentation and Validation

DONE

Prepare presentations
Chalmers
Ascom

Complete report

Formulate final result

Validate with nurses

End of design phase

Picture 1.6: Process

2. Theory

The theoretical framework for the project is compiled in this theoretical chapter. Included is information within several different fields which are all relevant for the subject as well as for the design result of this specific project. The chapter addresses contemporary research about communication in a healthcare context, usability and form, theory about the human memory and physical ergonomics.

2.1 Communication in healthcare

Aiming to increase the theoretical understanding of the hospital environment in general and of nurses' surroundings in particular, papers and research articles within the area were read. This information gave the project group important insights influencing the execution of the coming field study, and the findings within each of the fields of nurses' environment, nurse- and patient communication and nurse-to-nurse communication are presented in this section.

2.1.1. Nurse environment

In a recent study conducted by Linda H. Aiken et.al (2011) it is claimed that poor hospital environments are common and result both in decreased quality of care and also affect the nurses working in them negatively. Furthermore it is claimed that an improvement of the work environment would be beneficial if not necessary for the patient care quality as well as for the nurse retention.

According to Aiken's study in 2011, between 26% and 44% of the nurses at the investigated U.S. hospitals considered themselves to have poor work environments. The hospitals with pervaded better environment ranking also had a lower percentage of who were dissatisfied with their jobs and a lower rate of burn outs. Further, the authors suggested improvements to maintain the nurse workforce and to increase the safety and quality of care. Those improvements regarded better physician-and-nurse relations, more nurses involved in hospital decisions and greater management support.

Though, another study (Aiken et.al, 2001) says that many of the recent changes committed by hospital management have been configured to imitate industrial models of productivity improvement, rather than addressing the specific concerns of the nurses. Finally the authors say that in addition to concerns about constant insufficient hospital nurse staffing, "there is every reason to believe that the problems in work design and workforce management that are reflected in the responses of the 43,000 nurses in our study contribute to uneven quality of care, medical errors, and adverse patient outcomes."

2.1.2 Nurse and patient communication

According to a study done within the acute-care after heart infarct, it is fundamentally trust that provides the basis for a person-centred communication between the nurse and the patient. It is developed by the nurse's availability and presence by the patient throughout the whole hospitalisation and not only during the emergency phase. The study also showed that nurse-and-patient discussions targeted on individually adapted action plans specifically developed for each patient could ease the patient's rehabilitation. (Liljeroos et. al, 2011)

Patients participating in the study said that nurses' mixture of humour and skill generated an open atmosphere, which facilitated discussions of difficult topics. Nurses were also generally described as calm, objective and professional, which made the patients worry less about their situation. Further the researchers conclude that trust was built in cases when the nurse was both accessible, present and showed interest in and understanding of the patient's anxiety.

Also, the patients expressed that information given during medical rounds regarding their disease was sometimes difficult to understand, and the physicians often appeared to be in a hurry. Therforee, the patients turned to nurses who were more accessible than the physicians to ask "stupid" questions and to receive explanations for complicated medical terms. However, the patients sometimes had a hard time remembering discussions with nurses, for instance one patient expressed that: "There was a nurse here talking, but what we talked about I hardly remember. It was a bit about the disease and risk factors and that sort of thing".

How nurses introduced a conversation was seen as important for how well the patient would receive the information. If the nurse started with something like "I'm sure you've heard this before", the patient in many cases interpreted this as standardised conversation and therfore lost their interest and focus. Also, many of the patients in the study asked for another kind of information than what was given. Whilst the patient wanted to discuss implications from an emotional perspective, they understood it as that the nurses wanted to give them standardised information about lifestyle changes and risk factors. There were even some patients that thought about those conversations as role play, where the nurse was supposed to talk and the patient supposed to know, but in fact they both knew it would not lead to any

changes in the patient's behaviour. At the same time, it was said that the lack of knowledge could lead to both inactivity and uncertainty during the rehabilitation, because the patient was not aware of the lifestyle changes they were required to do. Therfoore, it was particularly important for the patient to be sure of where they could turn to if they had any additional questions after discharge from the ward. For instance a phone number to call if needed would be positive for the patients to have which often worked as a safety net. (Liljeroos et. al, 2011)

2.1.3 Nurse communication

According to an observation study that was carried out by Ohlsson and Persson in (2007), the written communication between nurses is reduced when handover (information transfer between two shifts) is mainly conducted orally. Their conclusion was that this affected the quality of patients' medical records negatively since it generated more unclear and diffuse patient descriptions. Ohlsson's and Persson's recommendation was to keep a high level of documentation in the medical records, since it is not suitable to use oral communication only. According to Kristoffersen (1997) the written documentation is fundamental for patient security, since the information revealed in an oral report is both complicated and inappropriate to trust as a single source. Further, documentation in the medical records should make it possible for the nurse to quickly get a distinct picture of the patient and the care previously given. Nevertheless, according to Eggland and Heinemann (1994) the oral report fulfils an important complementary purpose to the written documentation since it makes it possible for nurses to focus on the most important information in the handover, which the next nurse then could take into consideration during their shift.

2.1.3 Legal requirements

There are a couple of national reguations which are of importance when it comes to understanding of how information flows within healthcare institutions can go, and the two most fundamental ones are presented below.

Personal data law (Personuppgiftslagen)

Personuppgiftslagen (PuL) is since 1998 a Swedish law that defines how it is allowed to collect, register, save and spread personal information about an individual. The essence of the law is that any

organisation collecting personal data should provide sufficient information about what it will be used for. (Datainspektionen, Personuppgiftslagen, 2013)

Patient-data law (Patientdatalagen)

Within healthcare, there are special rules regarding how personal information can be handled and it is regulated by the patient-data law (valid since 2008.) It includes i.a. that an employee within healthcare can have access to patient data important for performing a care-related task. This is clarified by authentication requirements and access control to the information. (Datainspektionen, Patientdatalagen, 2013)

2.2 Usability and form

Since an important aim of the project is to develop a useful design, theory about usability and form was seen as relevant to use in the development to reach a sufficient final result.

2.2.1 Usability terms

Usability is commonly defined as:

"... the extent to which a product can be used with effectiveness, efficiency and satisfaction by specific users to achieve specific goals in a specific environment" (ISO DIS 9241-11)

According to Jordan (1998) effectiveness means to what extent the task/s can be performed, Efficiency describes the effort required to perform the task and satisfaction tells how satisfied the users feel when performing the task. Also it could be described as a quality that occurs in a use situation, and is therfoore an interactive property which is determined by the users, the use situation, the task and the product.

The term Guessability describes the effectiveness, efficiency and satisfaction with which a specified first-time user can manage specified tasks with a product or service. Learnability measures how learnable a system or design is, by measuring the effectiveness, efficiency and satisfaction with which a specified user performs tasks on a specified product, after previous use. (Jordan, 1998)
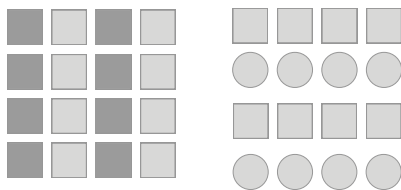
2.2.2 Gestalt laws

The gestalt laws describe how different visual patterns are perceived. According to Boghard et.al (2008), there are different definitions of the gestalt laws, though four common laws are those which describe similarity, proximity, continuity and closure. These four laws are illustrated in picture 2.2.2 and explained according to Bohgard (2008).

Similarity means that objects that have the same colour, form or size are perceived collectively. (see picture 2.2.3a)

The *proximity* law implies that objects close to each other are perceived as groups, meaning that the left picture is perceived as one group of balls whilst the right picture is perceived as four groups of balls. (see picture 2.2.3b)

The law about *continuity* says that visual, auditory and kinetic patterns are expected to continue in the same direction rather than taking a new direction. (see picture 2.2.3c)

Closure explains how figures that are not entirely complete are often perceived as complete, and thus they can generate a more realistic image of the figure than what is actually showed. (see picture 2.2.3d)

2.2.3 Principles of Usable design

There are several definitions upon usable design, and some important ones are described in this section according to Jordan (1998).

Consistency, says that the same symbols, figures and placements should have the same signification within the system and design (inner consistency), or according to other systems and products.

Consideration of user resources, means how well the system and design is adapted for its users, meaning for instance its tactile, visual and auditory properties.

*Feedback*, describes how well the user understands if an action has been performed, and its consequences.

Error prevention and recovery, measures how easy it is to make errors within the system, and the consequences if such is done.

Visual clarity, means how well the content of the system could be perceived.

User control, defines the perceived control the user experiences when operating on the system.

Prioritisation of functionality and information, tells how different functions and information have been prioritised in the system to increase the usability.
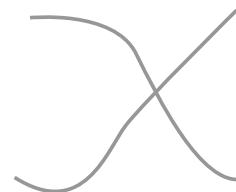
Explicitness, says how well a system provides clues about how the system is used, meaning how intuitive it is.

Picture 2.2.3a: Similarity
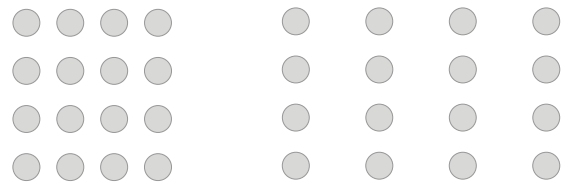
Picture 2.2.3b: Proximity

Picture 2.2.3c: Closure

Picture 2.2.3c: Continuity

2.3 Memory

The design result (described in chapter 8. Result) deals with memory assistance to some extent. Of this reason, it was seen as advantageous to use theory within the field in the concept development about how the human memory works. This section describes some relevant terms within the research area memory.

2.3.1 Short term memory

As Nelson Cowan (2010) describes in "The Magical Mystery Four: How is Working Memory Capacity Limited, and Why?" G.A Miller suggested in 1956 that an average human could remember seven (+/- two) chunks in short-term memory. According to both Nelson and Ebba Elwin (2010) later researches have shown that there could be a more precise capacity limit, at three to five chunks. Further, those numbers are said to be affected by the environment, for instance it is shown that stress and high volumes have negative impact on the short time memory.

2.3.2 Retrieval recall

In 2010, Ebba Elwin described the term retrieval recall, which means that the retrieval of information from memory is eased by clues, for instance a symbol or sign, or the initial letter of a word. Also feelings could work as a retrieval clue, called mood congruence. Another term is priming, meaning to evoke associations that facilitates the information processing, which often is done without noticing.

Further, Elwin says the environment could initiate the reproduction of a memory (a recollection), and the more similar the environment is to the original situation when the memory was created, the easier it is to retrieve it.

2.3.3 Visualisation

According to Pascale Michelon (2012) a commonly used method to increase the memory capacity, is to create strong visual links between a specific object and the thing to remember. This could be any object, for instance a green jacket, which then be hung on a imagined laundry line, and by associating things to remember with the jacket, a strong memory will be created. Also Ebba Elwin (2010) speaks about visualisation as an important memory encoding method

2.3.4 Clustering

Elwin explains clustering as a way of structuring for instance series of numbers into small groups (clusters), and through that reduce the memory capacity needed for remembering the whole sequence. By using clustering it seems easier to remember a long row of digits or a shopping list. Similarly, categorization is another way of reducing the memory capacity needed, which also seems to facilitate the recall of the memory itself.

2.4 Physical ergonomics

2.4.1 Hands and design of handheld products

Product design is one of the fundamental parts of this project to consider, and therforee some theory about physical ergonomics is relevant to explain some of the design decisions taken.

The hands are complex in function and abilities, and design of products to be handled by the hands should consider a number of different aspects. Efficient power transmission is important, as well as the user's comfort, control over the product and a formal expression signalling how to hold and use it. (Bohgard et.al, 2008)

If a rotational movement, a torque, of great power is to be transmitted along an axis that is grasped by a hand, the optimal diameter of the axis is around 45 mm. (Pheasant, 2003) The power of a grip depends on which grip type that is needed. For instance, a Diagonally full hand grip (see picture 2.4.1) is comparably powerful, with a maximum power of 150 N and 250 N for men and women respectively. (Bohgard et.al, 2008) Except for the angled wrist, the hand's position in this grip is also quite close to the hands natural position described in Pheasant (2003).

Sizes of hands can vary substantially between individuals as well as with gender. A table over two basic hand measures in (mm) can be seen in table 2.4.1, where perc. is an abbreviation for percentile. According to Socialstyrelsen (2010), 9 out of 10 nurses working in Sweden that year were female and since hand sizes wary with sex, that information is also relevant from a perspective of physical ergonomics of a product.

Measures/Gender	Female			Male		
Percentile	5	50	95	5	50	95
Hand length	159	174	189	173	189	205
Hand breath (metacarpal)	69	76	83	78	87	95

Table 2.4.1: Hand sizes

2.4.2 Sight and visibility

The eye vision is the dominant sense of humans and sight is also the sense which is used the most since approx. 80% of all sensory input goes through the eyes. Symbols in interfaces have to be clear and big enough for the user of the interface to be able to see and perceive the symbols. Letters are a common type of symbols, and they are recommended by Sanders and McCormick (1993) to be at least around 2,5 mm high when being read from a reading distance of 500 mm. (Bohgard et.al, 2008)

With increasing age the visual ability is commonly decreased, which can cause difficulties to read text and see symbols, especially in small scale. Darroch, et.al. (2005) have looked into favoured font sizes on small screens of people in different age groups, and found that a font size range between 10 and 11 was in general preferred (18-78 yrs.), while older people (61-78 yrs.) spoke most positively about size 12. (Darroch, et.al, 2005)

Colours of interfaces should according to Bohgard, et.al. (2008) be used with caution and only to enhance specifically important information as a complement to a symbol or text. They promote that interface design should primarily be done in grey scale.

Picture 2.4.1: Diagonally full hand grip (Bohgard et.al, 2008)

3. Prestudy

Several extensive user studies have been conducted by the company during the past few years. Therforee it was seen as advantageous for the Thesis project to benefit from that research as much as possible to ensure a good end result, even though the studies themselves were originally planned to pinpoint the specific requirements for the smartphone concept itself. To go through this documentation was also a suitable way of identifying possible areas to look further into during the coming field studies of the project which would focus specifically on accessories to the smartphone concept. Hence the information gathering of this project commenced with collection and analysis of company material concerning previous user studies conducted by the company, as well as descriptions of the smartphone system.

The geographical range of the previous user studies is throughout Sweden and also international studies covering Italy, France, UK, the Netherlands, US and Sweden. Since the smartphone concept is directed towards nurses, the user studies of the company have primarily been investigating that user group.

This chapter describes some compiled findings of the previous user studies of which are interesting from an accessories perspective. The information sources of the chapter are in the format of written and oral internal company material, and therforee the specific references are not given. The only exeption from this is section 3.5 which consists of findings from research on the current national debate in Sweden about health care and nurses' working conditions, and there the sources are newspaper articles and authority reports.

3.1 Hospital environment

Since the accessory design is meant to function in the same environment as the smartphone concept, being a hospital ward, it was seen as advantageous to look into the properties as well as people of this context.

3.1.1 Context

Hospitals mainly comprise of two types of care units, called provider units and consumer units respectively. The provider units, such as the x-ray-, surgery- and lab departments are suppliers of services towards the consumer units, which can be for instance an emergency department, a cardiac ward or a medicine ward.

The type of care the different care units are involved in can also be divided into two categories, being inpatient and outpatient care. When a patient for instance comes unannounced to the hospital emergency department, or has a booked appointment with a physician, it is part of the outpatient care. On the contrary, a patient who has its own bed in a ward, being a temporary home at the hospital, is subject to the inpatient care.

Picture 3.1.1 shows examples of what the different departments can be and the care they provide. The information flows have the most complicated structure in the Consumer Inpatient departments, and therforee the need for a dedicated healthcare smartphone is greatest here. Of this reason the Smartphone concept is primarily directed towards users in these departments, and consequently, also the design result of this project will aim at the same user group.
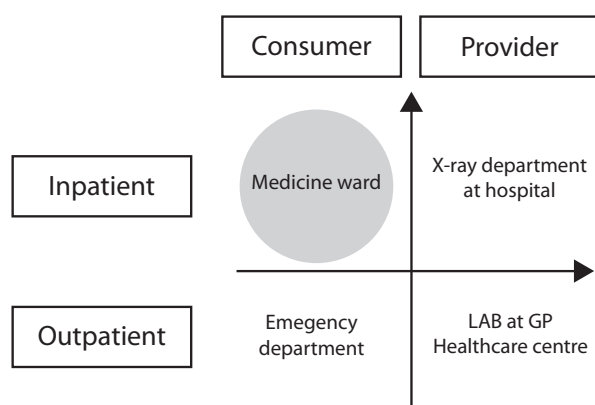
Picture 3.1.1: Ward types - examples of what the different departments can be and the care they provide.

3.1.2 People

The people present at a hospital ward are naturally patients, their families and different kinds of occupational groups. The ones working with direct patient care are generally nurses, nurse assistants, nurse coordinators, physicians and also physiotherapists in some cases, depending of ward type. The nurses have the overall responsibility of the care of the patients, and it is them together with the nurse assistants that most frequently work directly with the patients. The physicians have the overall responsibility for diagnosing and treatment of the patients and they are also assigned to a bigger number of patients per person than the nurses, leading to them not having as much contact with each patient as the nurses.

3.1.3 Communication tools

Nurses working at a ward have several different communication tools that they use to communicate with each other, the patients, medical devices, other parts of the hospital and the outside world. The most common is naturally direct oral communication since nurses speak to each other very frequently and constantly transfer information to their colleagues by telling and re-telling information throughout the working day. Phones are used mainly to call colleagues in and outside the ward, relatives to patients and other parts of the healthcare system. It is common to use pagers as a mean for internal communication, and a pager can also be configured to inform the carrier of a medical alarm from a certain machine monitoring a patient's medical values which is another common use area. Also the medical monitoring systems themselves can inform the users directly by sounds and messages at different kinds of screens.

If a patient wants to summon a nurse, it can use the nurse call system which comprises of a button next to the patients bed and screens and displays wherever nurses work throughout the day. When a nurse call is triggered, a text on the screens is instantly displayed informing the nurses about which patient it is that calls (often combined with an audio signal to attract the nurses' attention to the displays).

Many wards also have an alarm- and nurse presence system installed which is intended both for quickly calling colleagues for help in an emergency, and also for assisting the nurses in communicating whether there is any nurse present in a certain patient room or not. Every patient room has two buttons next to

the door on the inside of the room, one green (presence) and one red (emergency alarm), see picture 3.1.3a. The first nurse entering the room is supposed to press the green button to indicate presence, and then the last nurse leaving the room presses the green button again to de-activate the presence. The presence status of each room is shown on displays outside the room so that the personnel in the corridor can know if any nurse is in there without having to check themselves, see picture 3.1.3b.

Picture 3.1.3a: Button unit in patient room

Picture 3.1.3b: Corridor display

3.2 The client company

Ascom Wireless Solutions is a relatively large company which (as previously mentioned) designs, manufactures and sells products within the field of mission critical communication. The company has 1200 employees worldwide and is based in Gothenburg, Sweden where also the main part of R&D is situated. Ascom has its own production site in Herrljunga, Sweden where most of the products are manufactured and assembled. However, the products with the largest volumes are produced in factories in China and Thailand.

The company's products target healthcare, prisons, retail, manufacturing industries, retail, hotels and other businesses that require dedicated communication systems. The product portfolio reaches form network equipment that is installed at specific sites, to software and to hardware handsets such as phones, pagers, alarm systems and different kinds of calling systems. The current handset products from Ascom are constructed to be more durable than commercial phones, be relatively water resistant and to withstand chemical detergents during cleaning. The batteries are often replaceable since the products are designed for very frequent use.

Picture 3.3.4: Scrubs

3.3 Smartphone concept

The current products from the company are aimed at working satisfactory within several different contexts and use areas (such as hospitals, home care, prisons, industries and retail), and therforee the functions of today's products are very general rather than explicitly adapted to any specific use area. The company has identified a need for a personal communication product similar to a phone and a pager, but that is specifically developed for nurses in a hospital environment since this is the biggest user group. The product concept can be described as a smartphone adapted to use at hospital wards, and it is in parallel with this thesis project under development at the company. The Working Title of the smartphone concept is currently MYco, which is the term that will be used in the coming chapters of the report. Since the thesis project aims to design an accessory to the MYco concept, a description of the smartphone concept follows below.

3.3.1 Target user

The nurses do the daily care of the patients, and therforee they are the ones that need to take care of direct alarms and calls related to specific patients. Their daily work is also in general less predictable and scheduled than that of for instance the physicians. Furthermore, the biggest occupational group within hospital environments are nurses, and they have a big need for a dedicated smartphone. Of these reasons, the company sees a business opportunity in having nurses as the primary user for this product. The secondary users are nurse assistants who often are delegated tasks from nurses.

3.3.2 Hardware

The MYco concept is in its physical format as previously mentioned similar to a commercial smartphone having a relatively large touch screen and also a clip facilitating secure fastening in a pocket or on clothes. It differs however from an ordinary phone in similar ways as the company's products do today. The device is also supposed to have an external surface which can show a few characters and that is more visible to the user than the smartphone itself when carrying it. Also the overall product expression is intended to be more professional than that of a commercial smartphone.

3.3.3 Functions

Concerning functions, the MYco concept is supposed to be similar to an advanced pager enabling the user to receive personal alarms of different kinds, nurse calls and various notifications. In contrast to the currently most common alarm system at wards which attracts the attention of everyone working in a ward when an alarm goes off, MYco is meant to have the possibility to be configured to only receive the alarms that concern the specific nurse carrying that particular phone. The most important information is shown on the external surface so that the person carrying using it can grasp the content by just glancing at it.

The user can also initiate and receive phone calls, respond to alarms as well as benefit from other additional functions that are useful for a nurse in a hospital ward. MYco is supposed to allow text- as well as sound input, and also be able to play sounds in the same manner as an ordinary mobile phone. The concept is meant to have Bluetooth compatibility and also possibly some kind of localisation system. The interaction design of the smartphone concept is at the point in time when this report is written still very conceptual, but what can be said about it though is that it is meant to be intuitive, quick and easy to use for a nurse. Great effort is also put into getting the software's prioritisation of different task- and notification types right.

3.3.4 Use

A ward has nurses working around-the-clock and all year around in shifts. The smartphone is meant to function as a shared phone, meaning each smartphone device will not be personal for a specific nurse, but be used by different nurses from shift to shift. Each smartphone will be connected to a "nurse identity", which enables alarms to be configured explicitly to be directed towards specific identity. Hence, every device can be frequently used all hours a day and all days a week.

At wards in hospitals, the employees all wear a special kind of clothes called scrubs, see picture 3.3.4. The colours, length of shirt and placement of pockets differ slightly between different wards and countries, but the overall design and function is standardised. The MYco device is meant to be carried inside a pocket of the shirt, fastened by a clip on the product and placed relatively accessible for the carrier to reach.

3.3.5 Existing accessories

The function of the accessories to the handheld products that the company sells today is mainly either to endorse the physical properties of the product or the maximum use time. Within the first category are different carrying solutions such as spare clips, a security strap (to prevent damage when dropping the product) and leather cases for phones. Other company accessories that can be used to simplify the use of a phone are various headsets in different sizes with headphones or an earphone, a microphone and a cord connecting mobile phone and headset. Extra chargers for the products are also classified as accessories and can be purchased separately. There are two types of chargers, single chargers for one product (mainly designed to be placed on a flat surface) and chargers to be used with several phones at the same time. The multiple chargers are offered both for charging separate battery packs and also for charging the phones without removing the battery.

Within the category of accessories for maximising use time are the separate battery packs found, which are sold both to enable around the clock use of a single phone by just exchanging the battery, and also function as a spare part when a battery of a phone is outworn. In addition to this, coloured, exchangeable front plates for the phones are offered as accessories to ease identification by the users of a specific phone among other phones (without having to look at the screen where an identification text such as a name/ward is displayed).

3.4 Nurses and their requests

This section describes what nurse at a wards do, how it is to be a nurse and what functions in a smartphone concept that nurses see as important.

3.4.1 To work as a nurse

Nurses at hospital wards often work in so-called nursing teams or nursing pairs, consisting of one nurse together with one or two nurse assistants. The nurse has (as previously mentioned) a delegating function of tasks towards the nurse assistant/-s and each nursing team has the shared responsibility of a number of patients at the ward. Occasionally nurses have the sole primarily responsibility of patients without any nurse assistants in their team, especially during night shifts, but the most common is that

there are at least two people within a nursing team. If a nurse needs additional help with the care of their patients it is also very common for the nurses and nurse assistants from other nursing teams to assist their colleagues.

In their work at a ward nurses use a lot of different kind of technology which is intended both for communication and information like phones, computers and pagers, and also for medical purposes such as medical monitoring- and treatment equipment. To handle, dispense and deliver medicine to the patients is also a major part of the job. Nurses frequently read as well as write in the medical records of their patients, and they also take different kinds of notes throughout a working day which are destroyed after each shift. The notes are most commonly in written format on papers, and the way of use, quantity and style of the notes is highly individual. However, papers with notes can easily get lost which is sometimes seen as a problem with the system.

To work as a nurse in a hospital ward often means having a high workload with a lot of different tasks to keep in mind and do. Nurses are very often interrupted; both by alarms, patients, colleagues and others, and therforee they are highly skilled at prioritising and re-prioritising tasks and information flows whenever needed. They walk around the ward a lot during every shift, which is expressed in a field study as "nurses walk constantly". The vast majority of the alarms of systems installed at a ward that reach a specific nurse (see 3.1.3) are either false or not of particular interest of that nurse, and this can, in turn, cause so-called alarm fatigue. It means that the nurse's cognitive load gets so high they will not even hear or respond to their alarms as intended because the alarms are too many, too loud or too often irrelevant. The irrelevant/false alarm rate at a ward (which can cause alarm fatigue) is sometimes as high as 86-99% of the alarms that reach a specific nurse.

Because of the high workload, interruptions, risk of alarm fatigue and constant walking the nurse's job can be seen as generally stressful. However, nurses are often highly empathic persons, always with the patients' best interest before their eyes and also the comfort of their nurse colleagues. Therforee they frequently ease others workload by helping, talking and comforting, both patients and colleagues, no matter how hard their own working situation is. Nevertheless there is a strong wish from nurses interviewed in the previous field studies to have more time for talking to and taking care of each patient.

To work as a nurse (Ascom's image bank (2013))

3.4.2 Ranking of functions of Smartphone concept

The previous field studies have addressed both needs and requirements of the user group and also which specific functions that nurses at hospital wards need and wish for in a future smartphone concept. This section addresses the evaluation and ranking of functions that was done in the previous international field studies. In general, some national differences in nurse requirements were found, but most of the functions were wished for to an equally extent by nurses from all the included countries.

The most important functions to the nurses are for instance to receive alarms, calls and lab results. Functions as "To-do-list with reminder", "Localise colleagues", "Write patient notes" and "Timer" were also prioritised relatively high (between 3 and 4 on scale from 1 to 5, were 1 means Totally unnecessary, and 5 means Would love to have).

3.5 External voices

During the past few years at the time for this project's execution, both the Swedish healthcare system in general and also nurses working conditions and relatively low salaries in particular have been debated animatedly in the public sphere in Sweden. The contents and arguments of this debate were seen as both relevant as a general climate barometer of how it can be to work as a nurse in Sweden today, and also potentially useful to apply in the project, and therfoee selected parts of the publications are briefly described in this section. Even though the potential problems themselves are often the same for nurses and patients, the consequences can vary and therfoee this section is divided into Nurses' perspective and Patients' perspective.

3.5.1 Nurses' perspective

The article series in four parts by Zaremba (2013) in the newspaper Dagens Nyheter describes how the public management within healthcare seems to be controlled by price lists of cures for different diseases to a big extent, and that the personnel have to put a great deal of their time on administrative tasks instead of taking care of patients. According to an anonymous former patient quoted in Zaremba's article "Vad hände med det sunda fönuftet?" (Swedish for 'What happened to common sense?') (2013a),

the saving obligations and increased efficiency with minimal amount of workforce have somehow tuned into the normal state. A severe lack of hospital beds is common in many hospitals, especially during summer time, and according to Zaremba's article (2013b) Sweden has less than half the amount of beds per capita than at least nine other European countries.

The series has drawn a lot of public attention nationally in Sweden, and it is evident that the subject is something that engages people and that they can relate to. This debate is in the project group's opinion a sign of that the everyday working conditions of nurses in Sweden needs improvement, and perhaps a relatively small change through use of more efficient communication tools can contribute to this change.

3.5.2 Patients' perspective

Another point of view on nurses' everyday work which is potentially interesting in this project is that of the patients receiving care. Also their various experiences have attracted attention in national media during the recent years and the saving obligations on healthcare institutions do of course also affect them in different ways.

The Swedish Agency for Health and Care Service Analysis ('myndigheten för Vårdanalys') presented a report by Docteur and Coulter in 2012 about patient centeredness in Sweden's health system, containing a thorough analysis of the current state. Some of the main difficulties described in the report are that "Swedish patients are more likely than their international counterparts to say that their providers do not spend enough time with them", and that "relatively little information, education and support for decision-making is as yet available to assist Swedish patients who want to take a more active part in their health care process, and that the information available is not provided in the most useful ways to foster and support informed patient decision-making". Vårdanalys points out that "While evidence regarding the patients' experiences in involving family and close friends in their health care is relatively limited in depth and scope, available data suggests that there is room for improvement in this area". Another interesting finding presented is "According to the views of experts interviewed for this study, Swedish health care is organized for administrative convenience rather than patient or even provider convenience."(Docteur and Coulter, 2012)

3.6 Compilation prior Field study

The problem areas detected in this prestudy are mainly those of nurses' stressful working conditions and cognitive workload, and patients' lack of information. The findings that served as direct input to the next phase of the project can be divided into two types, being the problems that had not yet been addressed by the smartphones concept, and the areas that had not yet been particularly investigated in any of the company's field studies.

3.6.1 Problems not yet addressed by the smartphone concept

Most of the functions requested in the company's field studies (see mainly section 3.4) had already been considered to be included in the smartphone concept, even though some solutions had been further developed than others. However, an interesting area that had not yet been addressed in particular is the patients' needs and requirements.

3.6.2 Areas not yet addressed in the company's own field studies

Following the prestudy of the project was an own, project-specific field study (described in Chapter 4.) based on the previous ones, and since specific user requirements on accessories in particular had not yet been addressed by the company, it was a main purpose of the field study to investigate this new area. Also the patients' perspective was concluded interesting to look into as well as how the functions of the smartphone concept in general could be enhanced and through that even more useful to nurses by the use of designated accessories.

4. Field study

When the theoretical study was finished (documented in 3. Prestudy and also parts of 2. Theory), the next step of the project was to do an own field study specifically adapted to the scope of the thesis project. The aim of the field study was to through interviews, observations and surveys identify potential problems and problem areas that nurses have when working at a hospital ward. By dividing all findings into different areas, and thereafter analyse the areas further; the final outcome of the study was intended to be a distinct description of one or a couple of problem areas assumed to be solvable within the frames of the thesis project.

Outcome theoretical study

Outcome field study

Interviews   Observations   Surveys

KJ 1

KJ 2
2 main areas

part pres.

4.1 Methods and process

4.1.1 KJ analysis I

To build a foundation for the field study, a KJ analysis was performed upon the outcome of the theoretical study.

A KJ analysis is a method used for categorising and structuring gathered information from for instance user studies. The method is usually performed in the middle- or at the end of a study phase. Firstly, the outcome of the study is written down on post-its. When all data is compiled, the post-its are then spread out on an over-viewable area, and notes containing similar information are clustered together. The last step is to identify and name different groups with content connected to the same area. (Straker, 1995)

Throughout the project, a reduced version of a KJ-analysis was used twice; firstly to identify the main problem areas found during the theoretical study and the initial interviews, and secondly to clarify and enhance those areas by adding information from the remaining interviews, the observations and the surveys. (See picture 4.1.1)

When starting up the first KJ analysis, quotes and notes of interest from the prestudy was the input together with information gathered through the interviews. Since the questions of the interviews were chosen with the theoretical study results in mind, the information from the interviews naturally addressed the same areas as the theoretical study, thus the chosen categories remained suitable in this step. In addition to the main areas, which contained the majority of the gathered information, there were also some smaller groups and sub-groups consisting of less specific information.

4.1.2 Interviews

Interviews within the field study were held for several reasons; to get a deepened general understanding of how nurses communicate and work, to get more information within the identified areas of interest, and to fill gaps from the theoretical study.

A common way of identifying the user needs in a certain context is to conduct interviews with users who have experience from the actual field of interest. The interviews could be performed individually or in a group. Typically, there are three categories of interviews:

- Unstructured, meaning that the user and the interviewer discuss around a subject, without any predefined questions.

- Semi structured, implies that the interviewee openly answers to predefined questions, and the interviewer has the possibility to dig deeper into a subject by asking supplementary questions.

- Structured, where the responder has to choose between predefined answers to specified questions. The response alternatives may consist of a line on a scale or alternatives in a list.

To avoid a misleading outcome it is important that the interviewer does not ask questions in a way that may affect the interviewee's responses by avoiding to ask leading questions. (Jordan, 2002)

Picture 4.1.1: KJ analysis 1

To find wards that would be suitable for interviews, the project group contacted nearby hospitals that had wards with inpatient care and that were not too far away from the project group's base in Gothenburg, Sweden. Wards having relatively intensive care had a higher priority, since the chance of identifying suitable problems in that kind of context was thought to be higher than at low intensive wards. However, traditional intensive care wards were also avoided since the nurses working in that type of wards rarely leave the patient rooms at all, and are therforee in little need of a portable communication concept like MYco.

Altogether, five wards were visited, and the aggregate number of interviewees was nine. Most of the interviews were semi structured and held in small groups with two participating nurses, albeit one of the interviews was made individually.

The profession and area of responsibility differed between the interviewees; one was head of the ward, three were coordinator nurses and five were regular nurses. The age varied between 30 and 60 years, and the professional experience from working as a nurse varied between three years up to about 30 years. All the interviewees were women, which was the most common gender by far among nurses at the wards visited.

The interviews started out with comparably straightforward questions, for instance profession, age and experience. After that, the topics became more complex and open, with questions such as "How could and should the communication at the ward be improved?" were asked. Since the previous theoretical study and the KJ analysis had formed the basic problem areas to be investigated during the user study, most of the open questions asked during the interviews addressed these specifically defined areas.

After the first interview a few questions were removed or changed, making the following interviews more effective and targeted at finding relevant information. The main changes were done to put less focus on the subject of alarms, something that was not meant to be a main subject for the field study since the company's previous field studies had investigated this problem thoroughly and the smartphone concept itself would also focus on addressing it. This subject still stole time during the first interview though, since some communication problems often existed (at the wards) related to alarms.

All interviews took between 60 and 90 minutes, depending on how much extra information the interviewees replied to the questions they got. After completing an interview, the project group and the interviewees often ended up talking a bit more informal around the subject and the overall situation, which also gave useful additional information about their working situation that had not been covered in the interview itself. (For interview questions see Appendix 1)

4.1.3 Intermediate presentation of field study

Midway through the field study (after 4 interviews), outcomes from the early part were presented to representatives of the company. The presentation consisted of information both of where and how the initial interviews had been performed, and about which the identified areas of interest were. In addition, the previous theoretical study was presented, which had contributed to the areas as well. After the presentation discussions were held regarding which areas the remaining studies would focus upon. The outcome of the discussion was that the observations and the final interview would prioritise three main areas. These areas of interest were identified through a combination of the information gathered during the initial prestudy and during the interviews. Although other areas were identified as well the conclusion was that these subjects did not suite the thesis project as well as the areas chosen.

Also, a decision about creating and sending out surveys targeted specifically towards former patients at wards was taken. This decision was a result of the determination that one of the main areas for further focus regarded patients.

4.1.4 Observations

Observation is a method for investigating a specific surrounding or environment from a potential user's own perspective. Shadowing is an observation method where the observer (so-called shadow) is following the user, who is performing his or her tasks just as they would do if the shadow was not present. The shadow could thereby benefit from observing the user in its natural environment and context. Through this, it is possible to identify a problem or a solution that the user themself is not or do not want to be aware of, and by that also something that would be hard or impossible to captured during an interview. (Quinlan, 2008)

Throughout the field study phase, shadowings were conducted both at Kungälv- and Uddevalla Hospital. A picture from an observation can be seen in picture 4.1.4. The main focus was to identify specific problems within all of the three fields chosen after the intermediate presentation. The shadowings were prepared by creation of a written document with proposed informal questions for the shadow to ask if or when an opportunity would rise, and areas which the project group wanted to investigate.

Kungälv

At Kungälv Hospital one of the project group members shadowed a nurse during a day shift, whilst another group member shadowed a nurse during an evening shift. Both observations were non-participant, meaning that the shadow was passive and not a part of the work at the ward.

The two nurses who were shadowed had similar experience; they had worked as nurses for five years, although one of them previously had worked at another hospital.

Throughout the observations the project group members took notes upon everything the nurses conducted. Also, time-stamps were taken to get information about how much time nurses put on different tasks. The observers also got the opportunity to join the nurses during a handover and by that gaining an increased the understanding of that particular step. Furthermore, it made it possible for the project group to identify what kind of events of the ones that had taken place during the observed shift that were retold to the nurses at the next shift at the handover, and consequently, understand what the most important events were according to the nurses.

Patients were in the notes named after their position at the ward (on the format of room:bed), both since that is how the nurses named them, but also to withhold their anonymity in the notes.

Picture 4.1.4 Observation - nurse makes medicine

Uddevalla

The two observations at Uddevalla hospital were conducted during a day shift between 07.00am and 3:00pm. One of the shadowed nurses worked as a coordinator, which means that that person has more communication with other nurses and other wards, thus less communication with patients and relatives. The other nurse worked as an ordinary nurse during the whole shift, although she sometimes worked as a coordinator.

The experience among the shadowed nurses varied. The nurse who worked as a coordinator during the shift had about 30 years of experience, whilst the other nurse had about 10 years of experience.

A difference comparing this ward to the ward at Kungälv Hospital was they here had a 30 minutes morning meeting in the beginning of the shift. During the meeting the nurse coordinator spoke about special events during the day, if a patient needed special treatment, food restrictions etceteras.

Likewise the observation study in Kungälv, notes and time stamps were taken during the whole session, although some information unnecessary for the project was left out.

All notes from the observations were within the next days transacted into digital format to be analysed and structured. The information gathered was used to strengthen and emphasize some areas of interest. Also other findings reduced the importance of some areas, like the one called Identification of device. Together, the observations gave a good perspective of how nurses work out in the real world which was thought to be of great importance when starting the idea generation, which would give the project group the possibility to put early ideas in a context and situation.

Later on, the findings from the observations were divided into the same areas as formed during the initial field study phase.

4.1.5 Surveys

A survey is a method for collecting information from a high amount of users, without forcing the investigator to communicate with responders one by one. A disadvantage is that the investigator will not have a chance to ask supplementary questions, making it harder to get deeper insights into questions of interest. The questions can be both open and closed, and the initial questions are usually more informative, whereas the later questions require more reflection from the responder. Surveys could be sent either digitally or in printed versions, but the former facilities the approach of delivering and collecting the surveys.

Two different surveys were sent out, aiming for two different user groups; nurses and patients. The survey towards nurses had similar questions as the interviews, although it was somewhat reduced and angled towards the identified areas of interest such as patient communication and their memory work. For instance, one of the questions was "what kind of information do you want to have access to all the time?". (for all surveys, see Appendix 2 and 3)

The survey regarding patients was targeted to those who had been hospitalised during the past year. By reducing the allowed time since their stay at a ward, potential losses and changes to their memories were assumed to be reduced. The questions were oriented towards the patient's own experience; for instance how they felt like during their stay, what information they were asking for and what they eventually felt was missing or could be improved.

In total there were 11 responses to the survey to people who had been patients hospitalised within the latest year. The majority of the respondents were in the age between 20-29 years, but one person was between 50 to 59 years. The complementary survey for nurses got 13 responds. The professional experience among the nurse respondents varied between 3 months and 9 years, and their age varied between 20-50 years.

4.1.6 KJ analysis II

The second KJ analysis consisted of the information from the later interviews (number 3, 4 and 5), the four shadowings, the patient- and the nurse survey. Since the main areas for those studies were based on the first KJ analysis, a high amount of this new information matched the categories in the first KJ analysis and therforee solidified these. All areas were at this point filled with quotes from interviews and surveys, notes from observations and facts. Together the findings created a certain view and understanding of each area, and problems within it. Each finding also was given a classification, depending on which part of the user study it came from:

(I)   Interviews

(O)   Observations

(SN)   Survey Nurse

(SP)   Survey Patient

4.1.7 Choice of area

At the end of the field study, it became evident to the project group there were three main areas which seemed more suitable for further work than the others. Though, according to discussions with the company and project supervisor, it was decided to sort out one of the three fields. The two remaining areas that were decided to stay in focus during the design concept development work were presented to the company, all together with quotes and notes that were significant for these two areas.

4.2 Result

All information gathered during the field studies was structured and analysed, creating a list of all important findings. (See Appendix 4 for full version.) Those findings were as previously mentioned divided into areas, filled with quotes from interviews, observation notes and survey responses. The structure facilitated the decision about which fields that would be best suited to take through to the idea generation phase. The different main areas and their sub categories are briefly described below, together with quotes typical for each area.

4.2.1 Context

Information within this area included various findings that rather gave an understanding of how the nurses work, more than specific problems within the environment. An example of the information is that all the wards visited had three shifts similar times, divided into day, evening and night. The most common way to work was in pairs or teams of three, even though this differed between wards and shifts. The nurses at the wards were divided into different teams; for instance blue, green and red. All patients were assigned to one of these teams, which meant that the same team were responsible for the same patients as long as they (the patients) were admitted to the ward, reducing the number of nurses involved in one patients visit.

One problem identified, was that there were often too few phones and pagers compared to the number of nurses due to organisational issues.

4.2.2 Non-communication

The non-communication area regarded findings about how nurses carry, bring and clean their electronic devices such as phones and pagers. Most of the nurses were carrying the phone in their shirt or pant pocket, and it was either hanging outside the pocket with a clip, or put inside, which was said to be individual. One nurse also said that an Ascom security strap was used for her pager, since she tended to drop it. Cleaning the phone was only done occasionally when it was dirty, but regular cleaning of the electronic devices was neither observed nor expressed in the interviews.

4.2.3 Alarm to nurse communication

Alarm to nurse communication consisted of the sub categories alarm levels and nurses' reaction to alarms and was mainly findings from interviews and observations. Since MYco addresses and aims to solve all common problems and findings within this area, not too much focus was put on alarms within this thesis project, even though several findings indicated and solidified the need for the concept of MYco: "Silent pagers would be nice, since using it would reduce the amount of noise, and the concerned nurse would just get the notification through a vibration. (I) "

Further, many wards were described as very noisy, contributing to a bad working climate.

4.2.4 Nurse to nurse communication

Communication between nurses was one of the areas of biggest interest, resulting in a large amount of information gathered. According to both interviews and observations, nurses spend much time on finding each other and finding medical devices: "All our communication mostly consists of that we are running around looking for each other" (I)

This was a common problem at all examined wards, although all wards and nurses seemed to solve it in one way or another. Some nurses used the telephone, some yelled for each other, some asked someone else for assistance. In most cases, the searching for someone or something was task-dependent, meaning that the nurse looked for help when they needed to perform a task, and therfoee required either practical assistance or information regarding how to perform the task. Since most task were time critical, all delays regarding to searching for colleagues increased the stress: "The stressful environment makes it hard for the personnel to communicate with each other properly, since everything has to be done rapidly." (SN)

Another identified category within nurse to nurse communication was the handover, which according to the interviews often took more time than necessary. There was also a great risk of Chinese whispers, meaning false interpretation of oral information. The possible consequences could sometimes imply patient danger, and during the shadowing some errors were propagated between two shifts, creating confusing situations: "Chinese whisper is a problem, because everything is interpretations and therfoee misunderstandings can easily be propagated." (I)

It was also discovered that the handover resulted in that a nurse became aware of mistakes or things they had forgotten during the shift. "During the handover the nurse becomes aware of tasks that have been forgotten during the day and asks if the nurse for the next shift can do those tasks." (O)

An additional sub-category was medical records, both reading and writing. The software used was claimed to be both ineffective, time consuming and hard to understand.

4.2.5 Nurse to self communication

The second main area, nurse to self communication, included e.g. memory assistance in the format of notes to self in various types; post its, notes on the hand/arm, note pads and egg clocks. Information within this category came from both interviews, observations and surveys. Especially during the surveys, where some questions were investigating the Notes to self are, it was shown that particularly new nurses were worried about forgetting stuff and therforee they were taking notes of almost everything. This was also confirmed by interviews where some interviewees spoke about how they used to take much more notes when they were new at the ward. "The hardest thing when I was new was to remember all the small things" (SN)

According to the nurses' experience, ordinary notes was not always enough, especially when a task was time dependent: "To just write information and reminders down doesn't really help when it's something you should do." (at a specific time or situation) (I)

Some nurses experienced difficulties in remember that they had taken a note at all. Another issue was the interruptions. One nurse said in an interview that "since we always have things to do, we are per definition interrupted as soon anyone wants us for anything." The interruptions were said to increase the risk of forgetting things, also the nurses had to spend time and effort on remembering what they were doing before they were interrupted. "Due to interruptions some information could get lost which for instance could result in that a patient needs to ask for analgesics several times or that one patient misses its X-ray time and needs to wait for another opening." (I)

During the observations it became clear that interruptions was a major problem, since also the nurses shadowed realised they had forgotten to do something several times as a consequence of an interruption. Reminding notes were rarely written when interrupted or when speaking with colleagues though: "Nurses ask each other a lot of patient-related questions throughout the day but do not always take a note of the answers. Notes are mainly taken in conjunction to handover or more formal reconciliation. "(O) Still, according to both the surveys and interviews a lot of nurses were aware of the high amount of interruptions during their working day. "We are constantly interrupted and we don't manage to complete task A before we have to start task B" (SN)

4.2.6 Patient and nurse communication

The patient and nurse communication areas consisted of three identified sub categories; communication between nurses and patient, communication directed from patients to nurses and communication directed from nurses to patients. The main problem identified within this area was that the patient asked about more information than the nurses were able to respond to.

The patients not only wanted the nurses' time and attention, but also detailed information about their condition and a future plan of their stay at the hospital. Especially the questions about the plan was something the nurses experienced that they couldn't reply to, since the time until for instance a lab result often was unclear to them as well as to the patient concerned. "The patients often ask for a plan for their stay/care, and information about upcoming events and their health status." (I)

According to the patients it would be nice with some overview document or digital solution to faciliate the understanding of their own process. "If one would have gotten an overview of what will happen right in the beginning of the stay at the ward, it would have been really nice so that one understands a bit and don't feel so disoriented." (SN) Another opinion was that it would be good to know that the nurses were moving close by: "I had no need for talking or similar, but it gets lonely very quickly when you are lying "tied to a bed."" (SN) which corresponds with what a nurse said: "They (the patients) want to make sure they are not forgotten or missed." (I)

4.2.7 Other obstacles and ideas

The last area rather consisted of additional discoveries made though out the user study, potential solutions and various ideas, than of identified problems. Those ideas were divided into sub-categories of new technologies, patient privacy and stuff-related. The ideas were not considered suitable for further work within the project, although they still contributed to a general deepened knowledge regarding different kind of communication.

"The wards have a centrally placed staffing whiteboard where the nurses can write and see who is working on the shift. (O)"

"A ward has a notepad lying in the reception where the nurses can write down tasks for the ambulant nurse ('springsköterskan') to handle." (O)

"The physician dictates the medical record by using a computer-connected Siemens Dictaphone. (O)"

4.2.8 Summary

As an overview, a summary of the most important findings within the different areas is presented below in table 4.2.8.

4.2.9 Choice of area

Three areas seemed more suitable for further work than the others, since they described distinct and widespread problems that were clearly expressed both by nurses and former patients. Also, these areas had the potential of having several possible design solutions that could fit into the thesis scope:

Nurse <-> Patient - Meaning the communication between the patient and the nurse, called the Patient's perspective or Patient journey.

Nurse <-> Nurse - Regarding the communication between two nurses in the context of a handover.

Nurse <-> Self - Memory assistance for a nurse, with a specific focus on interruptions.

According to the discussions with the company and project supervisor, it was decided to sort out nurse to nurse communication. This was mainly because of the limitations of broadness such a solution would mean. How nurses perform a handover varies a great deal between wards. Favourable improvements within the handover field would probably most have consisted of organisational changes, which would be solution types outside the project scope and also outside the competence of the project group. Even though the area was scraped, the need for a better way of performing a handover still was strong, and therforee this need was clearly communicated to the company at the end of the field study.

Thus, the two remaining areas were:

• Memory assistance, addressing Nurse to self communication

• Patient experience, regarding patient and nurse communication

Area	Findings	Problems identified	Field study method
Context		Few phones per nurse / ward	Interviews
Non-comunication	No regular cleaning of device. Usage of security strap.	Nurses do not clean their phones.	Interviews, observations
Alarm to nurse communication	Nurse does not always respond to alarms calls.	The high amount of alarms has in several cases caused alarm fatigue. The alarms create a noisy and stressful environment.	Interviews, observations
Nurse to nurse communication	Nurses are looking for each other as well as devices a lot. Handover procedure varies between wards and nurses.	Hard to find either correct information or competence. It is difficult to know whether all information is transferred correctly during a handover.	Interviews, surveys, observations
Nurse to self communication	Nurses (especially new ones) write down a lot of information. Nurses are interrupted very often. Sometimes a nurse forgets to perform a task due to memory loss / interruptions / too much to do. Some nurses are afraid of forgetting things.	There is constantly not enough time for taking notes of tasks to perform.	Interviews, surveys, observations
Patient and nurse communication	Patients want to have detailed information about their own condition. Some patients feel insecure.	Nurses do not have the knowledge / information that the patients want to have, and often not the time to give the information either.	Interviews, surveys
Other obstacles and ideas	There are recent examples of new technologies that successfully have been implemented into healthcare, for instance smartphones connected to dermatoscopes.		Interviews

Table 4.2.8 Summary of findings

4.2.10 Requirements for memory assistance

By going through all findings from the field study, within the areas that regarded memory assistance, following requirements for a solution were written.

•   Facilitate the work for nurses, by lowering their cognitive workload

•   Work as a complement and relieve for the nurses' memory

•   Be as fast to use as pen and paper

•   Add value compared to nurses memory solution of today

•   Not increase the risk of alarm fatigue

•   Be adaptable for different personalities, situations and environments

Quotes memory assistance:

The following quotes were used to communicate and solidify the area of memory assistance:

Since they (nurses) always are doing something, they are (by definition) interrupted each time somebody wants them anything. (I)

I would like to have a reminder function for doing things like give insulin, take blood sample etc. Discrete reminders and easy to use." (I)

"The hardest thing when I was new was to remember all the small things" (SN)

"To just write information and reminders down doesn't really help when it's something you should do." (at a specific time or situation) (I)

"I'm afraid that I will forget something when we have this much to do" (SN)

"One nurse said that her memory is worse now than when she was new. She used her pen and notebooks, post-it's on her clothes and marker on her arm to make self-reminders. (I) "

4.2.11 Requirements for patient experience

In the same way as for the area of memory assistance, requirements for the area of patient experience were determined:

•   To increase the patients understanding of it's own healthcare process, within the hospital

•   To increase the feeling of comfort and safety

•   To facilitate the communication for nurses towards patients

•   To not decrease the time spend with patients

•   Not mean additional administration for the ward or the hospital using the solution

Quotes patient experience:

The following quotes were used to communicate and solidify the area of patient experience:

The patients often ask for a plan for their stay/care, and information about upcoming events and their health status. (I)

One patient says that "If one would have gotten an overview of what will happen right in the beginning of the stay at the ward, it would have been really nice so that one understands a bit and don't feel so disoriented". (SP)

One patient wants to know that the nurses are moving close by. "I had no need for talking or similar, but it gets lonely very quickly when you are lying "tied to a bed". (SP)

The kind of information that patients perceive as important to the nurses to give is: (SP)

- How future treatment is to be performed

- "They want to make sure they are not forgotten or missed." (Says nurse regarding patients) (I)

As an overview, a summary of the most important findings within the different areas is presented on next page in table 4.2.8.

5. Idea generation

This chapter describes the idea generation phase and its iterations. By using different idea generation methods described in methods and process, a huge number of widespread ideas and functions were developed, all aiming to solve problems within the two main areas which were identified in the field study. The ideas were continuously refined which made them more specific and distinct during the whole phase, where the most solidified ideas are explained in the result section.

Outcome field study   Outcome idea generation

KJ 2
2 main areas

Focus groups   Brainstorming

Design ideas

Work shops
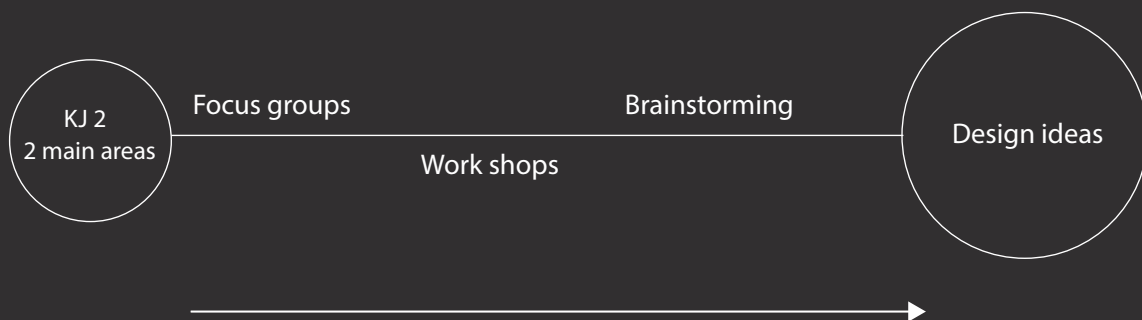
5.1 Methods and process

5.1.1 Focus group

Focus group is a method for discussing and developing ideas together with users who have expertise within the subject of the project. To reach the maximal efficiency the participants should have experience and expertise within different fields, and through that chance is increased of creating relevant ideas with a high validity.

During the initial phase of concept development, two sessions of focus groups were held. The focus groups were organised under an event that the company held at its office called "Framtidskväll", where the project group members had one a station. The sessions included six nurses, participating in groups of three by three. The nurses had various experience within different fields (outpatient care, psychiatric care, hospital wards, coordinator work and home care). None of the participants had previously had any contact with the project, why a short introduction to the context was needed in the beginning of each session. Questions and topics for discussion were prepared in advance, with variations between the two sessions. The goal was to receive additional information and demands, and also at least one useful idea of a problem solution within each of the two areas chosen for future development; memory assistance and patient journey.

The questions proposed were very open and aimed to trigger the participants' imagination to a high extent. When a question was posted, all participants were supposed to start with thinking, writing down ideas or sketching them on a paper, and then the group members were asked to explain their thoughts to the others and add additional input to each other's ideas. Due to time limitations, all questions prepared were not posted, but only the most essential ones. Below is an example of how the sessions were done. (See Appendix 6 for all questions)

Method: "Imagine a reminder device that could remind / alert you about anything anytime. How should it be like? When and how should it remind you?"

Questions:

- Imagine you had photographic memory, or a device who recorded moments for you. What should you use it for?

- How can you transform those ideas into the specific situation "Nurse patient communication"?

5.1.2 Creative workshops

Group Brainstorming

Focusing on the two main areas of interest, eight different group brainstorming workshops were conducted. The number of participants varied between two and five in each group, except for one workshop which had just one participant in addition to the project group members. The workshops consisted of two separate parts, one focusing on the patient experience whilst the other one was targeting the area of memory assistance. Which part that was addressed first and last respectively was alternated to reduce the effect of creative exhaustion among the participants when reaching the second subject.

The participants had a wide range of different professions; fellow students at Chalmers Industrial Design engineering, programmers, interaction designers, project leaders and Industrial Engineering students. Participants who did not have any previous knowledge about the thesis project or the MYco concept were given a short introduction. Also all participants were given an introduction regarding a nurse's work at a ward and what kind of tasks and challenges they are facing. The aim with the group sessions was to find alternative solutions and new approaches to the problems identified, as well as to give strength to previously discovered solutions by using the expertise and the different qualifications among the attendants.

Synectics

During some of the brainstorming sessions, the participants were given the possibility to use a modified version of the method Synectics. It is an idea generation method, mainly used for finding alternative and unexpected solutions to complex problems. The original version is based on analogies, where the participants are solving the same problem in another context (for instance a fantasy world) and then adapts the result for the original (intended) environment. (Nolan, 1989)

In the cases where Synectics were used during the sessions the participants were asked how they would solve the actual problem in their own working environment instead of at a hospital. When coming up with an idea, they were asked to fit this idea into the context of a ward, and thereby make the idea more useful for the thesis project.

5.1.3 Idea generation

During the period of prestudy, interviews, surveys and observations, several ideas had formed just from the group members hearing, reading and observing problems and potential solutions. Those ideas were written down or rapidly sketched with ink pencils in the initial part of this phase. See picture 5.1.3 for an example of what it could look like. By sketching and brainstorming both individually and together in the project group and trying to solve different problems identified within the two areas with a design, a huge number of ideas of great variety were created within a short period. The process of brainstorming and building on the ideas from the focus groups and creative workshops continued throughout the whole idea generation phase, although the ideas became more and more specific and detailed the later in the phase that they came up.

5.2 Result

5.2.1 Focus group

The sessions resulted in recommendations for what the future concepts would have to consider, and one of them was the importance of the possibility to set a time for reminders. It was said that the time when the task was supposed to be done was often more critical than getting complete information about what exactly the task was, since the task could be

recalled through a reminder at a specific time, whilst a timer could not be set by just writing down the task. Thus, an idea of an egg timer, with the possibility to have several parallel timers evolved. Further, according to the participants of the focus groups the most common things nurses had to remember were:

- Visiting patients

- To make phone calls

- Ask patients if their medication have had the desired effect (for instance painkillers)

- Change drop, change of PVC (abbreviation of peripheral venous catheter) or give blood

During the field study some nurses said they did not need any help to remember things they did on regular basis (time scheduled) like medicine delivery, which was confirmed by the participants in the focus groups. Another interesting topic that came up was a solution idea to create reminders using voice recognition, since it would increase the accessibility and speed of setting reminders while simultaneously performing other tasks (compared to writing something down).

Regarding the area of patient communication, the most prominent and frequent idea consisted of a display or touch screen, which would work as a medium for features and functions fulfilling patients' requests for information. The participants mainly mentioned the following areas where such a product would be useful in their work.

- To answer patients' questions about healthcare equipment

- To keep the patients updated about their work situation, if they were busy etceteras

- Clarify the time perspective of the care for patients, "How much time is soon?"

- Show pictures related to the current medical situation of the patient to them.

5.2.2 Creative workshops

The workshops created a high amount of different ideas within both of the selected areas. Seen to the spread, the variance and amount of different solutions were greater within the field of memory assistance, although the ideas within the patient experience field consisted of more distinct product solutions. All ideas were carefully considered and thereafter brought to the analysis and concept creation phase. See pictures 5.2.1a, b and c for some example sketches from the creative workshops.

5.2.3 Idea generation

All ideas produced during the focus groups, the individual brainstorming and the workshops were initially separated into the two main areas. The ideas differed both regarding level of novelty and feasibility, and whilst most of the ideas consisted of very brief ideas or simple sketches, some ideas were more developed. To compress the quantity of the ideas, they were all read through and evaluated regarding both how realisable they could be and also how well they suited the requirements identified during the field study e.g. how well the solutions addressed the problems identified concerning memory assistance and patient experience. See picture 5.2.3 for some example sketches.

The degree of technical solution development among the ideas regarding memory assistance was greater than the one within patient experience. Also, the ideas within memory assistance were much more similar to each other, meaning that the range of different possible product solutions within patient experience seemed wider.

Picture 5.2.1a: Workshop Sketch
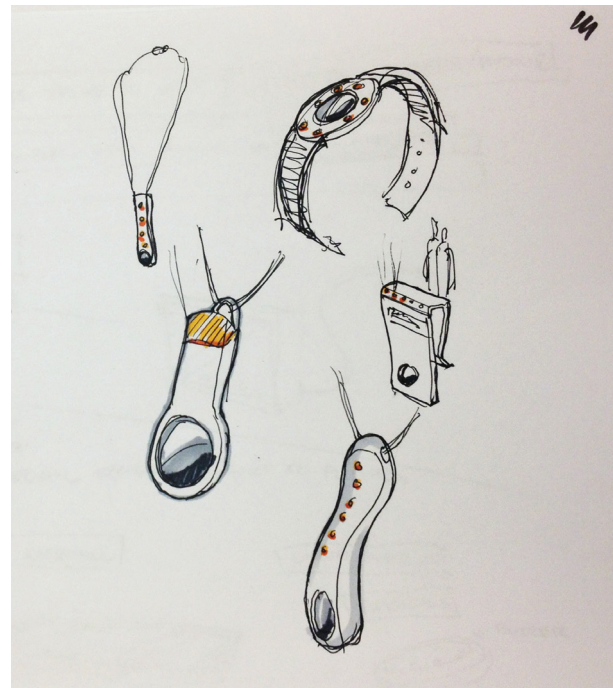
Picture 5.2.1b: Workshop Sketch

Picture 5.1.3: Idea generation
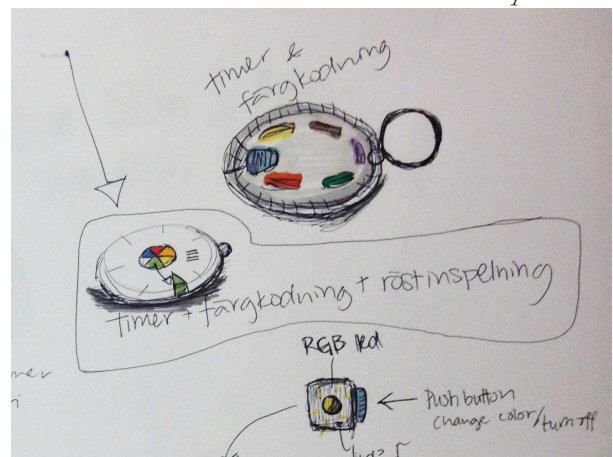
Picture 5.2.1c: Workshop Sketch

Memory assistance

All ideas regarding memory assistance targeted for the same goal, namely to facilitate the memory work for nurses. The solutions were either digital or analogous, and a majority of the ideas included some kind of categorisation or prioritisation of the different tasks to facilitate the overview of the reminders in a smartphone concept app. Voice recognition, voice recording and snapshot photos were also common ideas, argued to be much more simple to use during movements than pen and paper.

Another field of ideas concerned the principle of that nurses sometimes want to know that something is meant to be done at a certain point in time rather than getting a reminder of what the task itself is. Therfore any kind of timer could be useful, and one idea was for the nurses to just use an ordinary egg-clock. Additional examples of more analogous product ideas were use of stickers combined with categories, and task-dependent checklists. A combination of a digital and an analogous product idea was to make it possible to print out the to-do list created, and use the printed paper during the handover.

The size-, shape- and form suggestions varied and the input from a format perspective was noted, but at this point focus was rather put on discussing the functions of the product ideas than on forming finalised, comprehensive designs proposals. Although, if the device was suggested to be carried in a clip, in a pocket or in a keychain affected the possible design differently.

Furthermore, some ideas emerged about how and when a reminder could be received. Different occasions were discussed, for instance at a specific time, location, patient room or that the nurse themself would manually trigger a notification in some way.

Patient experience

Within the patient experience area, the ideas revolved around different solutions for increasing the patients' feeling of safety and comfort in connection to their stay at a ward. One identified mean for fulfilling this was to increase the understanding of the patient's journey, which could be done through somehow visualising it to the patient. Most ideas were about a screen or a digital tablet assigned to the patient's bed, with a time line representing the patient's stay at the ward ("the patient's journey"),

and also showing the upcoming as well as passed events on the timeline. The patient would then have the possibility to look at their own schedule and follow changes regarding their healthcare plan. In addition to that, the patient could also be offered to see scheduled daily events such as lunch- and visiting hours. Nurses and physicians would also be able to use the screen for showing for instance x-ray pictures. Other information that was proposed to be shown on the screen was how close the most nearby nurse was (in real-time) and feedback upon that a nurse has received the patient's nurse call. In addition to the screen, there were also ideas featuring a digital watch, which would present the same things as the screen, but around the patients' wrist.

Also a more analogue idea for visualising the patient journey was discussed, consisting of a board with a movable cartoon face on a timeline with several stations. The patient themself would then move the cartoon face in the same rate as they passes the different stages in the healthcare process. The board would then be a standardised model for a typical treatment process for other patients with the same condition as the patient concerned.

In addition the ideas addressing communication of the patient's journey, another idea was to transform the patient's room at the ward into a room very similar to the patient's own home and thereby increase the feeling of safety and comfort for the patient.

Another idea was to use a digital photo frame for showing a picture of the nurse currently assigned to the patient, making the patient aware of the fact that someone always has a responsibility for them, and also making them aware of changes in personnel between shifts. Also in which direction from the patient's present location the assigned nurse was located was proposed to be presented for the patient. A more complex idea was to have a device next to the patient's bed, which would provide signals in the format of a light each time someone at the hospital was working with the patient's case; writing medical records, analysing a LAB result, talking to relatives, discussing the patient's condition during a round etcetera. The device should not give the patient any detailed information about their process, but rather indicate that something is happening, even though it is not always directly visible (and therforee obvious) to the patient.
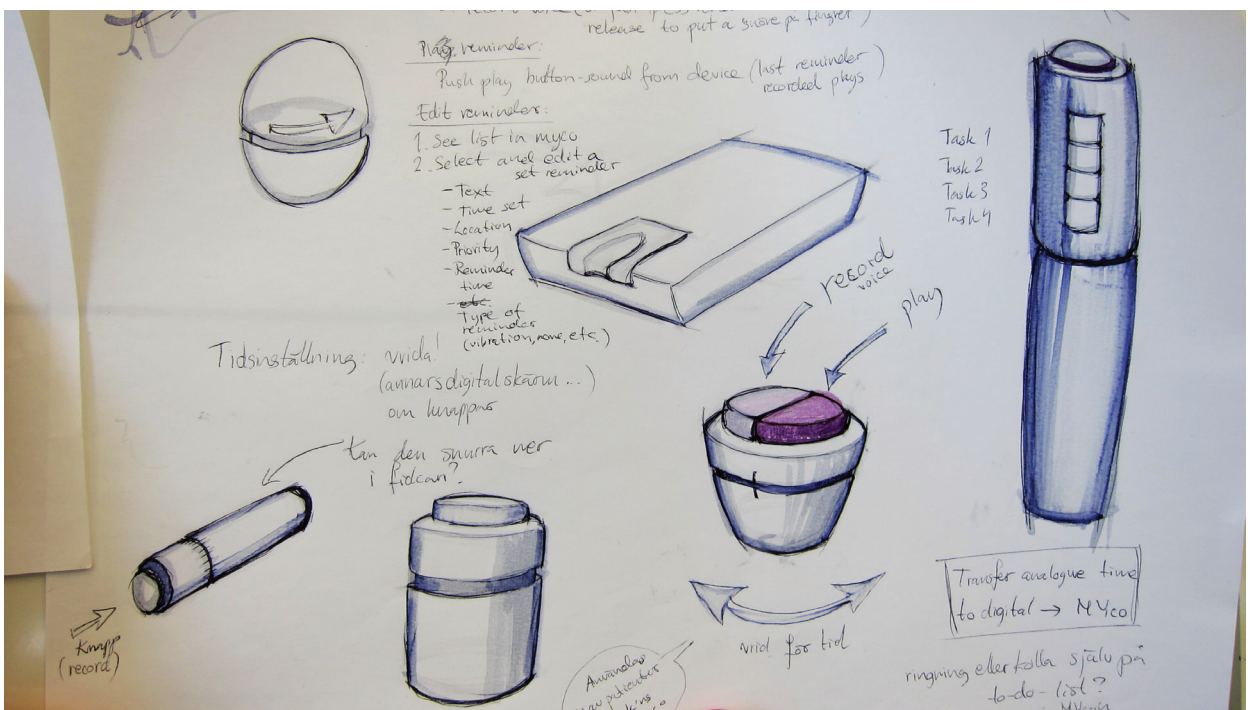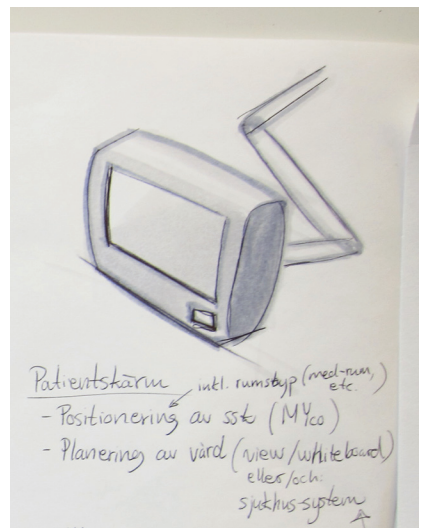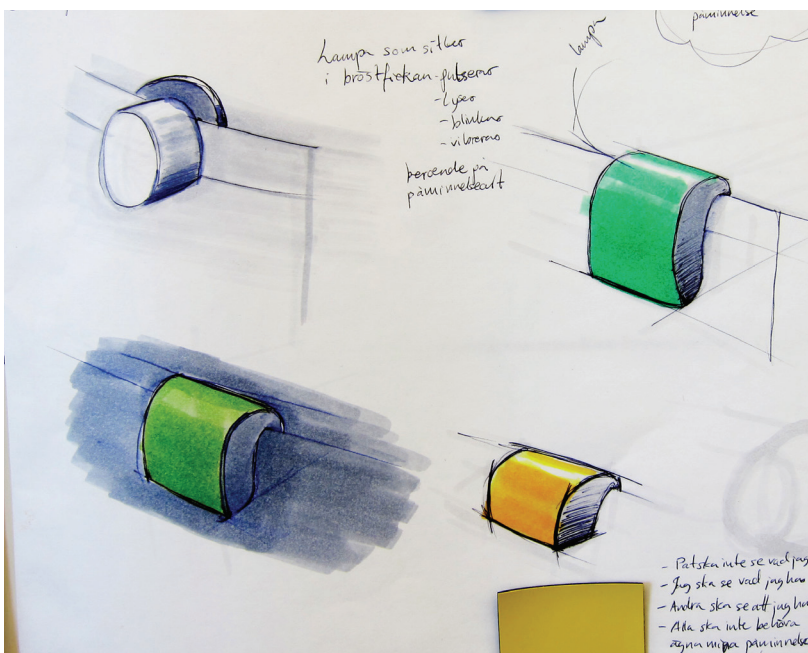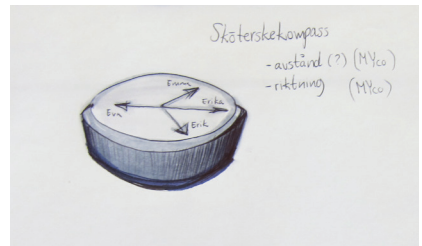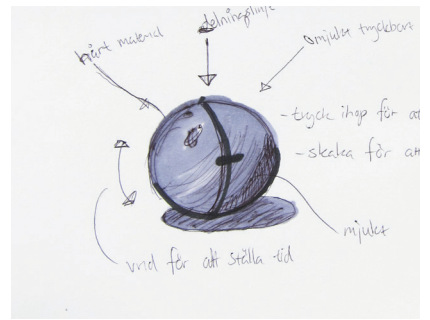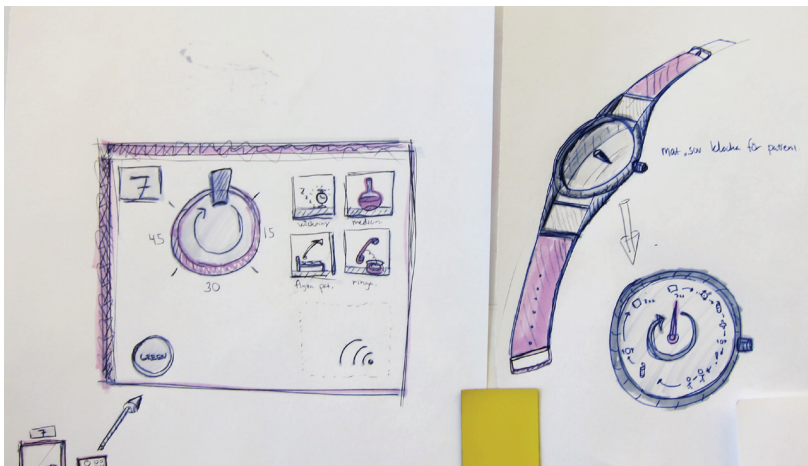
Picture 5.2.3: Idea generation Sketches

6. Concept development

The concept development was just as the idea generation divided into the two main areas; memory assistance and patient experience. During the idea generation phase a huge number of ideas had emerged, and the main challenge in the concept development was at this point to merge them into reliable concepts by packaging the desired functions into designs and then also communicating the concept through creation of informative sketches.

Outcome idea generation

Outcome concept development

Concept development

Design ideas

Morhological matrix

Concept selection
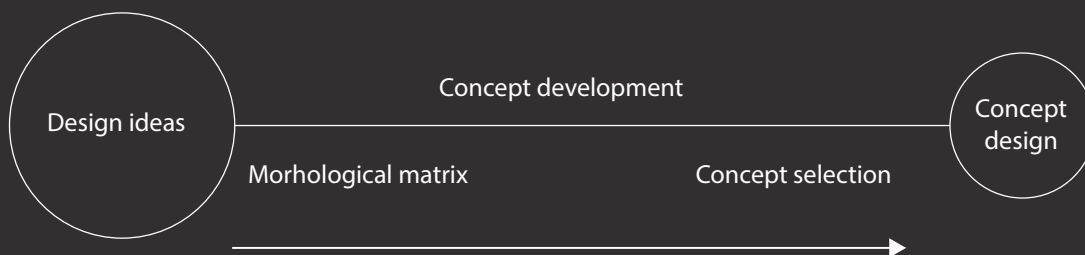
Concept design

6.1 Methods and Process

With the purpose of combining the different ideas into concepts a morphological matrix was used. It is a method for comparing and combining part solutions into completed concept designs. One axis usually explains the different purpose to be fulfilled, while the other axis explains the different solutions for each function of purpose. By choosing one or several part solutions for each function and then combine them, a concept which fulfils all requirements necessary can be created.

6.1.1 Development of concepts within Memory Assistance

By using a morphological matrix on this area, the high amount of ideas could be managed. Another advantage of using such matrix was that it could include a high number of part-solutions, meaning that the risk of potentially good ideas outside the future development was reduced. All part solutions within the memory assistance field were included in the morphological matrix. The solutions were thereafter ranked (1-4) according to how god they seemed to be. By combining different sets of solution a number of different concepts were created. All part solutions with the highest ranking were decided to be a part of at least one concept, while the solutions with lower ranking could be out-sorted if not they did not fit together with any other feasible part solution. The matrix consisted of 10 functions where each function described a special purpose, for instance "how to set time" and "how to get notification". See table 6.1.1 for full version. Different solutions and ideas for each step were then combined into four different concepts.

6.1.2 Development of concepts within Patient experience

The ideas about improving the patient experience were within a wide range, meaning they addressed slightly different problems although being within the same area. Some ideas were about a completely digital product and required development of a new software system, whilst some were much less complicated technically. Still they all targeted the same area; to improve the patients' wellbeing, feeling of safety and knowledge regarding their current situation.

Priority system	None	Position when IN	Time when IN - Cronological	According to set prio at IN	According to device config - Set task type prio				
Out (WHEN/HOW)	None / at request	Set time	Set time interval	Set location	Snooze function	"Do not disturb" function	At a fixed location		
Notification	None / on Smartphone screen	Light - Public	Vibration	Light - Individuall	Sound				
Info type	THAT it is something	Location for IN	Time for IN	Cathegory	Play recorded sound	Show taken photo / film	Patient	Collegue	
Confirmation	None	Eliminated after shift	Push / Swipe in Smartphone	Push / Swipe in Accessory	Blip at specific location				
Carrying / Placement	In pocket	On pocket / clothes	Upper arm band	On wall	On smartphone	Necklace	On ear	At station	At patient
Connection to Smartphone	IN: Accessory OUT: Accessory	IN: Accessory OUT: Accessory + Smartphone	IN: Accessory OUT: Smartphone	IN:Smartphone OUT: Accessory	IN:Smartphone OUT: Accessory + Smartphone				
relation to Smartphone	1 : 1	1:several	several:1	several: several					

Very green:	Must be included
Green:	Very interesting
Blue:	Interesting
No colour yet:	Not interesting

Table 6.1.1 Morphological matrix

To set up complete concepts, part solutions created during the idea generation were combined into more developed ideas containing of a set of different functions. Those combined ideas were then evaluated with consideration to the thesis scope and the technical feasibility of the ideas. After sorting out some unrealistic ideas and some that were not suitable for further development, the outcome of the patient experience areas were two different concept areas comprising of four different solutions.

6.1.3 Concept selection

To choose which direction the work in the coming phases would take, and to increase the transparency of the project towards the company, an intermediate presentation was held. To have this was something that was decided already during the planning phase, where it was concluded that a mid-presentation would give the company a chance to formally affect which direction the project would take, and also to comment and provide feedback on the track chosen. In addition to that, it was seen as beneficial to the project group to compile the accumulated design ideas into presentable concepts such as needed for an intermediate presentation, to have a concept deadline to meet, and also to gain distinctness and clarity in the development process.

Except from presenting concepts, the presentation also included the most prominent conclusions from the theoretical- and field studies, a description of the two chosen main areas and which user demands that were targeted during the idea generation, and a description of how the concept development had been executed. During the presentation the project group gave its own view on the different concepts (pros and cons). All thoughts and comments from the company were thereafter also taken into consideration when doing the concept selection.

6.2 Result

After completing the concept development phase, six concepts were defined with sketches and specified functions. Four of the concepts addressed the area of memory assistance whilst the other two were within patient experience. The concepts described in 6.2.1-6.2.2 were the ones presented to the company for the project group to receive feedback upon which track to choose for further development.

6.2.1 Concept area Memory Assistance

Simple

Concept Simple was a device similar to an egg clock, carried in the nurse's scrubs pocket. At the top it had several buttons with different symbols on them, which when depressed would be assigned a category (with an associated symbol) on the reminder. By rotating the upper part of the device, a time interval was set and this action also triggered a digital data transfer to the MYco. The transfer would comprise of a time interval (ticking down) and a category. When the time had elapsed, a notification would occur on the external display of MYco that the nurse carried with them, making them aware of that something within the chosen category had to be done. See picture 6.2.1a.

More advanced

The more advanced concept had two different buttons, one at the top (white in picture) and one at the left side (yellow in picture). When depressing the button at the top a recording was started and it continued until the button was released. To set a time interval, the nurse would turn a wheel on the right side to choose a desired time. If not turned, the latest adjusted time would apply. As soon as a new recording was made, the device would send the audio-clip to MYco. By using the yellow button on the left side, the latest reminder recorded would automatically be played.

When the time for a reminder had run out, the user would get a notification through a vibration and a light on the top of the device. To receive additional information regarding the reminder the nurse would use an application in MYco.

Through the clip, the device could be fastened either in a pocket or in the neckline. See picture 6.2.1b and c.
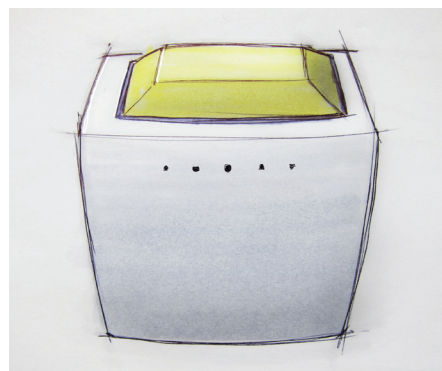
Voice recognition

The concept of voice recognition was in a way similar to the "more advanced" concept, using voice as an input source. The main difference was that the device only consisted of one button, for starting a voice recording. By using specified terms for task, patient and time interval, the information would be interpreted and transferred to MYco. Since

the device wouldn't include any speaker or output source, the handling of such information would take place in the MYco device, meaning that the concept focused on facilitating the input rather than the output. Like the former concept the device could be carried in either a pocket or in a neckline. See picture 6.2.1 d and e.
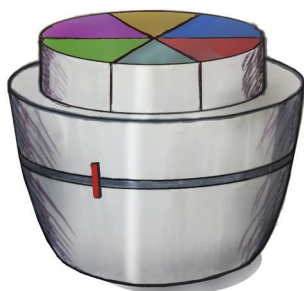
Non-personal

The fourth concept of memory assistance was a non-personal device, hanging on a wall. The product would be placed in several accessible spots on a ward, for instance outside patient rooms and at the reception. The product consisted of a wheel, for setting a timer and a number of predefined categories. By choosing a category and put the timer on the desired interval and then holding a MYco device towards the machine, the information about category and time would be transfer into the users MYco. See picture 6.2.1f.

Picture 6.2.1d: Concept Voice recognition
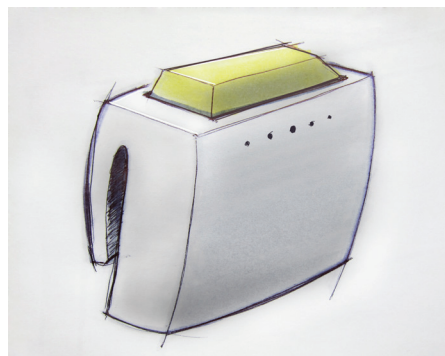
Picture 6.2.1e: Concept Voice recognition

Picture 6.2.1a: Concept Simple

Picture 6.2.1f: Concept Nonpersonal
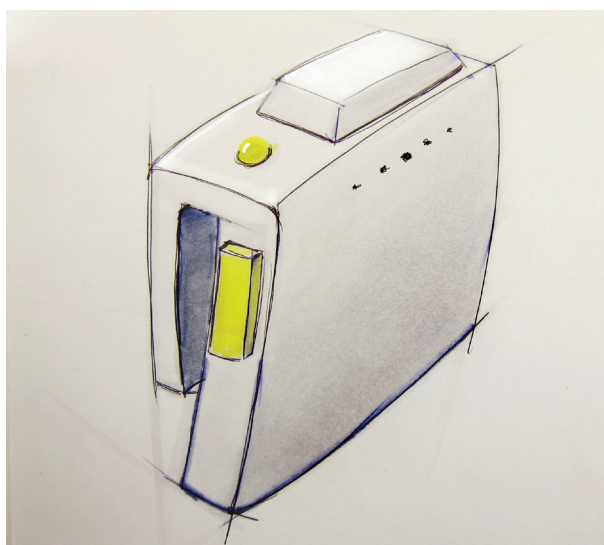
Picture 6.2.1b: Concept Advanced
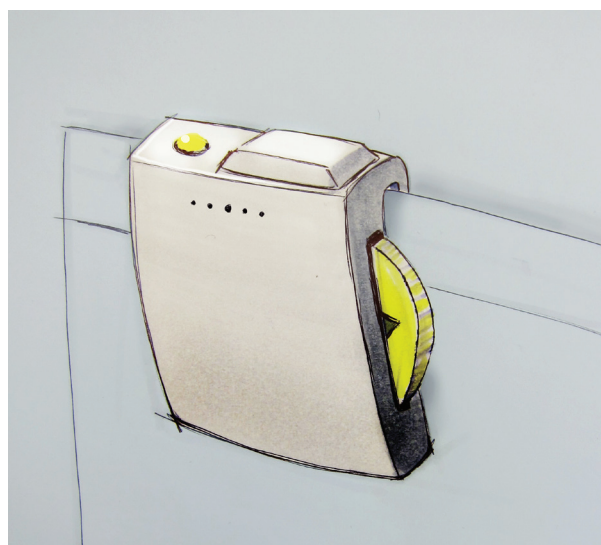
Picture 6.2.1c: Concept Advanced

Additional features discussed and considered for further development:

- A snooze function

- A Do not disturb function

- Automatic location and time tag

- No timer, making the task noted part of a to-do list

- Possibility to set priority of tasks

- Possibility for others to see availability of a specific user, depending on the amount of reminders the user has

6.2.2 Concept area Patient perspective

Patient comfort: Real time

The Patient comfort concept consisted of three functions addressing three main questions, all reaching for an increased feeling of safety and comfort.

- Who is my nurse?

The first solution consisted of a photo frame, aiming to present the nurse currently assigned and responsible for each patient. By watching the picture, the patient would through the picture always know for sure that someone had an eye on them, recognise the person in real-life and that knowledge would by that contribute to an increased feeling of familiarity and safety. The information needed would be reachable through a digital staff assignation system, and therforee no extra administration would be needed.

- Closeness to nearby nurses

For the patient to gain additional control and feeling of comfort and safety, the closeness to nearby nurses could be presented through a compass-like device, pointing at the closest nurse. To make this realisable it would be necessary for the nurses carry phones with localisation.

- Does anyone work with my case?

This concept addressed this question through notifying the patient about each occasion someone at the hospital is working with their case. From the patients perspective, this would be visualised through some kind of a glowing light. This feature could be integrated with either the frame or the compass.

To make the concept realisable, implementation of all digital systems like medical records, x-ray bookings, and laboratory answers would be needed. See picture 6.2.2a, b and c.

Patient journey: Timeline

A way of visualising passed as well as upcoming events for each patient was among the most desired patient functions identified during the field studies. This concept consisted of a display, placed beside each patient's bed. On the screen a timeline would be presented describing the date and time for future events, such as x-ray, surgery, planned discharge, etcetera. By navigating through the timeline, the patient may read details about events, potential preparations necessary and more. The patient would also have had the possibility to scroll back, and look through their own history of events during their stay at the hospital. By choosing the Today-view, the patient would see the events planned during the current day, but also everyday events like time for medications, breakfast and visiting hours.

The display would have to collect information from several different hospital systems; x-ray booking, transport, medical records, etc. Events like giving medicine and lunch hours are standardised in time at each ward and would therforee only have to be considered when installing the display system for the first time. Some content, like expected discharge, could either be collected from statistics from similar patients, or manually inserted by a nurse or physician. See picture 6.2.2.d and e.
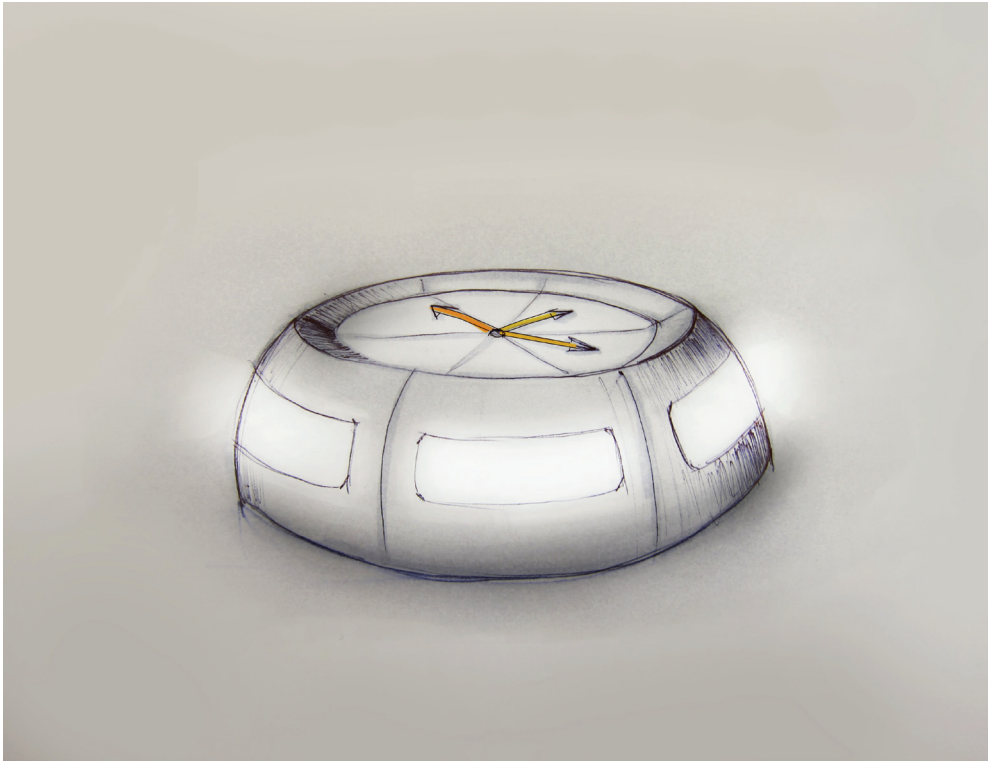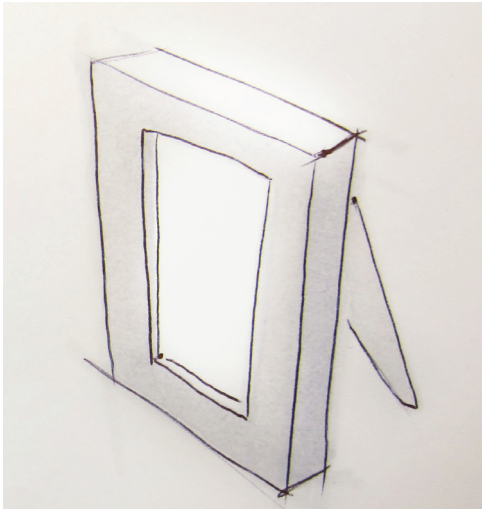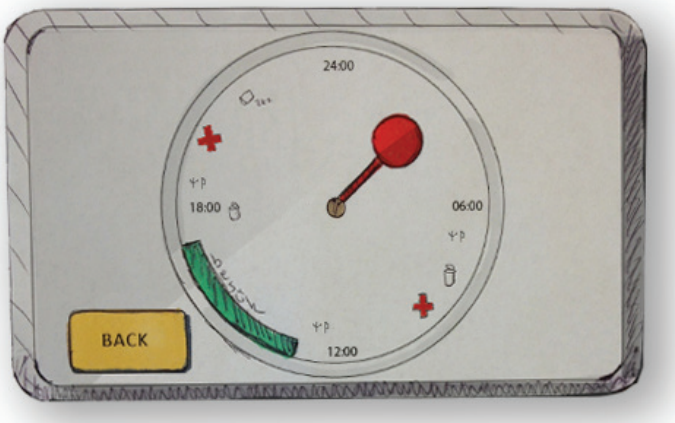
Picture 6.2.2a: Concept Real time
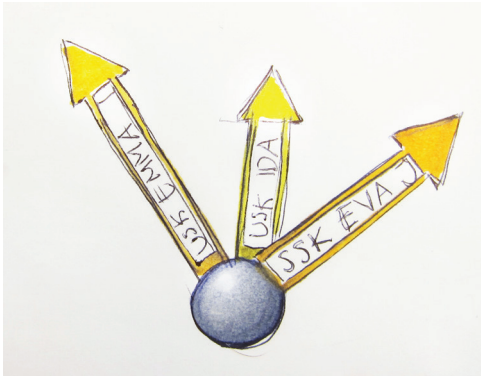
Picture 6.2.2b: Concept Real time
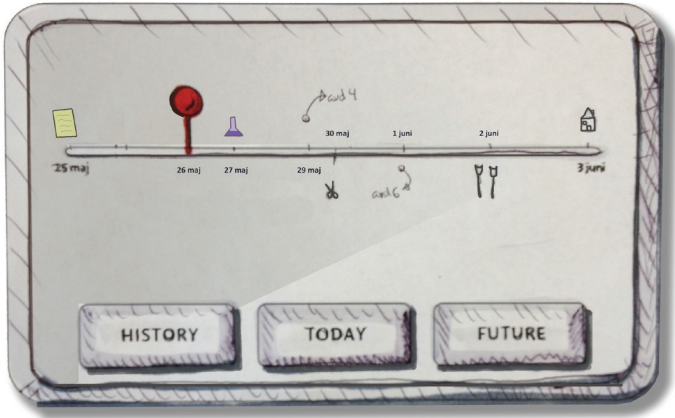
Picture 6.2.2d: Concept Timeline

Picture 6.2.2c: Concept Real time

Picture 6.2.2e: Concept Timeline

6.3.3 Pros and cons

To facilitate the overview of the concepts, a matrix of pros and cons was created which also gave the opportunity to re-think and evaluate the concepts once more. See table 6.3.3.

6.3.4 Concept selection

The concepts were evaluated both with respect to how well the concept addressed the demands identified in the field study and also how strong the correlation was between the identified problems and the concept, hence how well the concept solved the problem. Also the master thesis scope itself (see Chapter 1. Background) was taken into consideration when selecting which concept to be selected for further development.

Other aspects that affected the decision were:

• Technical feasibility

• The competence within the project group

• The company's thoughts and believes, according to feedback from the concept presentation

• Feasibility for production by company and the development time and effort required after the project would be finished

• The project group's own thoughts and believes about what to work with in the remaining phases

Firstly, a discussion regarding which area that was the most suitable for further development was held. It was concluded that the short term possibilities for implementing the Patient experience concepts with the MYco concept were limited, and also development of a completely new information system for the hospital was likely to be required. By that, the patient experience concepts were rejected, even though they were considered as highly interesting for future investigation by the company.

When the main track had been decided, the four alternative solutions for memory assistance for nurses were further discussed. In addition to previous evaluation criteria, also the user interaction was considered. The two main aspects for evaluation were therforee how usable the solution would be according to user requirements and demands, and the technological feasibility and maturity. For instance, the former was a drawback of the concept using voice recognition. Also it stood clear that the concept of a shared device was similar to an on-going development project at the company, making it less attractive for further work within the frames of the thesis project. By that, the two personal, handheld reminder devices, Simple and More Advanced seemed to be the concepts most suitable for continued development, and a combination of the two into one concept was decided upon to be further developed in the following phase of the project.
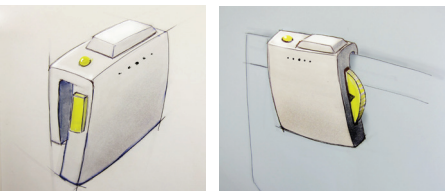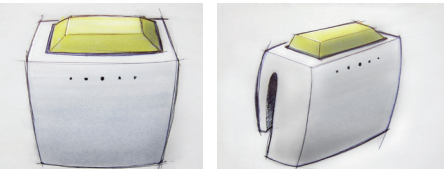
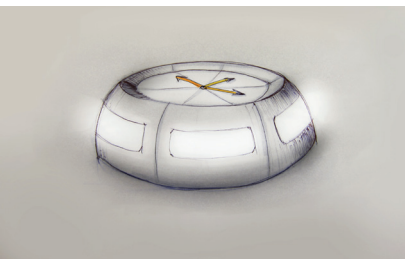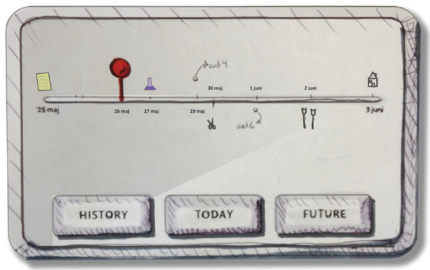| Concept	Pros	Cons
Memory assistance		
Simple	+ Easy and fast use + Addresses some of the most common requirements + Clearly linked to the MYco concept + Useful to all nurses at a ward	- Challenging to define symbols/colours - An additional gadget to carry in pocket - May cause an increased amount of alarms/notifications
More advanced	+ Possible to use whilst doing something else / being on the move + Addresses some of the most common requirements + Clearly linked to the MYco concept + Useful to all nurses at a ward + Easy to access the latest reminder	- Could only play the latest reminder without handling the MYco device - More technically complex - May cause an increased amount of alarms/notifications
C. Voice recognition	+ Really easy use + Addresses some of the most common requirements + Clearly linked to the MYco concept + Useful to all nurses at a ward	- Even more technically complex - Voice recognition is still not completely developed - Perceived safety aspect in trusting the technology - May cause an increased amount of alarms/notifications
D. Non-personal	+ Nurses do not have to carry an extra device + Power supply through the grid and no battery means no need of charging, hence favourable environmentally + Addresses some of the most common requirements	- May cause an increased amount of alarms/notifications - Not reachable in all situations - Cannot implement in small scale (to be used by one nurse) to begin with at a ward - Needs some kind of lock towards patients and relatives
Patient experience		
A. Patient comfort	+ Increases the comfort for worried patients. + Answers multiple questions in one product + Easy to use and understand, not very complex	- Technical and legal difficulties regarding automatic access to the medical records and other systems - The need could be questioned (not among the most obvious found in the field study) - Format and combination of functions yet to be explored - Unclear connection to the MYco concept
B. Patient journey	- Increases the comfort for worried patients by informing them about upcoming events - Facilitates the deepened understanding of the patient's health care plan - Supports nurses work by answering some common questions	- Technical and legal difficulties regarding automatic access to the medical records and other systems - Could be perceived as complex by some patient - Unclear connection to the MYco concept

Table 6.3.3: Pros and Cons of the concepts

7. Concept refinement

Once the concept track was selected, the concept refinement phase started off with an evaluation of the concept with some potential users. Based on that evaluation together with previous evaluations, the functions of the concept were specified. Then, the specification of the physical product followed, and also completion of an associated app for MYco. This chapter describes the concept refinement phase and how the discussions went regarding different aspects of the design.

Outcome concept development   Outcome concept refinement

Concept design

Function specification   Product development

User evaluation   App development
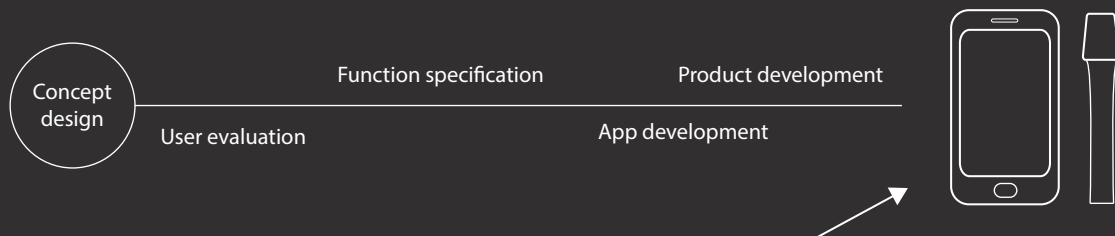
7.1 Evaluation with users

The user evaluation was done with two nurses at a ward which had been visited earlier during the field studies of the project. Semi-structured interview was the method used (see 4.1.2 Interviews) and the subjects were interviewed together for approximately 1,5 hour. The project group showed some different rough clay models of the physical product (see 7.3.1) and asked questions regarding both the concept as a whole and also about the nurses' thoughts, wishes and requirements of specific functions. Many of the questions posted had several different alternatives for the subjects to choose from, e.g. "Which format of the physical product do you prefer, format A or format B? Why?". The reason for this was that the project group wanted the subjects to be as neutral and honest in their answers as possible even though a half-finished concept was presented to them, something that otherwise could be understood as that the project group wanted mainly positive feedback.

Most of the thoughts of the project group were confirmed in the user evaluation, and the nurses interviewed where in general confident that they would trust the concept in working as required. They also thought that the concept would be useful for nurses and also used by the same. However some results of the evaluation were unexpected to the project group, such as that of requested category types (further explained in 7.2.1 under Category types) and to what extent a simple note function without a timer was needed. Also the wish of these nurses to be able to send reminders to colleagues was bigger than expected. The subjects' attitude towards recording their own voice was however positive. The detailed results from the evaluation with users are sorted into each application area in the sections below.

7.2 Functions specification

When the concept selection in the previous phase had been done, the potential functions of the final concept were discussed and elaborated around by the project group. An example of what it looked like when the project group was discussing the different parts of the user journey of the concept is seen in picture 7.2. The results from these elaborations formed the basis for the user evaluation (see 7.1) and after that; the functions were further developed and finally specified. Other aspects (in addition to the user evaluation) that were taken into consideration when deciding what functions the concept should have were detailed information (gained from various discussion with a number of different people at the company) about the potential functions of the MYco concept, hardware- and software aspects based on technical possibilities and market feasibility of the concept itself. This Functions specification then acted as a basis for the following refinement actions described later in this chapter. What the arguments were for and against each potential function are presented here in this section, divided into core- and additional functions of the accessory concept.
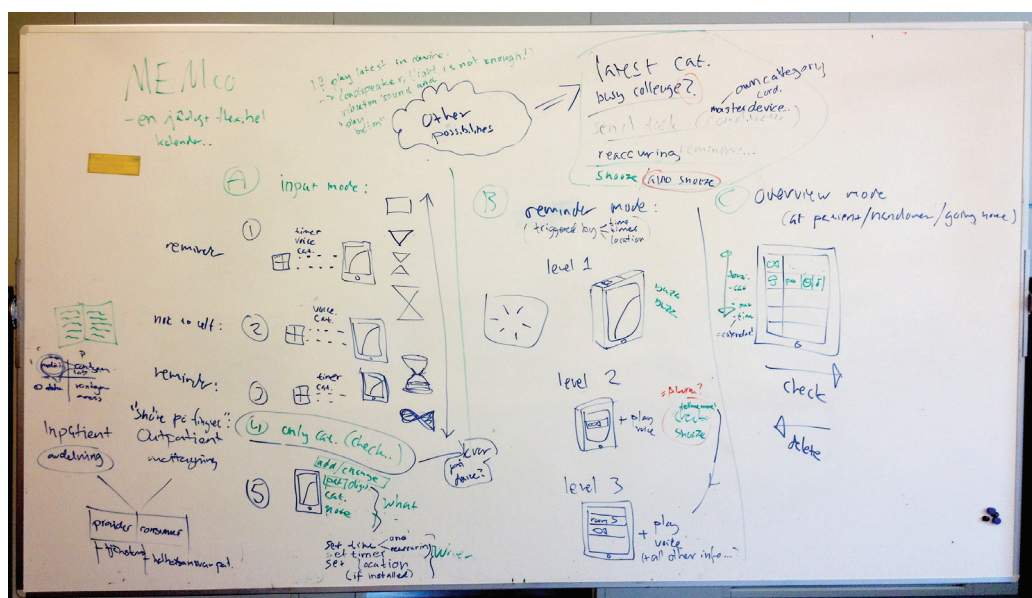
Picture 7.2 Whiteboard

7.2.1 Core functions

Core functions of the concept are the functions that can be seen as potentially central in order for the accessory to serve its main purpose, which is to help nurses remembering tasks by using some kind of reminder function.

Record sound is the first function which was discussed and elaborated around concerning the concept. By recording their own voice, a nurse saves time compared to writing something down with pen and paper. It should also be possible to design a recording product which is faster as well as easier to use compared to recording sound in MYco, both because of fewer use steps/clicks and also of the reason that the physical handling of the product can be optimised for that specific purpose. During the user evaluation it was confirmed that the nurses would be comfortable with using this function. It was also stated that it could even be an advantage for the patients comfort if they noticed that a nurse made a voice note when the patient told the nurse something, since it would give the patients a feeling of being listened to and taken seriously by the nurse.

Play sound is also a crucial function, given that the concept will record sound. However, how the sound is played and in which device (MYco or accessory) is not obvious and therforee that question was investigated during the concept refinement. If the sound would be played out loud without the user triggering it, is was considered to be an imminent risk the user would not feel like they was in charge over the product. Therforee a trigger from the user would be needed, but whether the sound would be played in MYco (which already had a phone function) or the accessory was seen as equally practical from a usability perspective. The users in the evaluation confirmed the hypothesis of the project group of the most time-critical moment in the use was when a reminder was to be set, and not later when it was to be received. Hence, to for instance clicking one button and listen in the accessory, or clicking twice on MYco and listen in there would not make a big difference use-wise. They also said that they would probably only listen to their voice recordings when not being in a patient room.

Set reminder in accessory is (combined with Give reminder) the function which would differentiate the accessory concept from a purely analogue note function the most when it comes to usefulness. It was therforee one of the most important focus areas

in the project to solve in a sufficient way, addressing both the properties of the function itself and to make it as practical as possible handling-wise.

One way to implement a reminder function would be by using a timer (meaning the principle of an egg clock) or to set a specific time. The timer could be integrated relatively easily in either MYco or the accessory from a technical perspective. However, the fact that the moment in time when a reminder is to be set was (as previously mentioned) seen as more time critical than when receiving the reminder, spoke in favour for setting the reminder in the accessory. The product design could be dedicated specifically to this single purpose, and therforee it had the potential of being quicker to use the accessory than performing the same task in MYco.

Another way was to set the reminder on a location within the ward where it should go off instead of at a specific time, which could be particularly useful to minimise the problem of nurses "walking all the time" to fetch objects as well as colleagues. This function was also discussed in positive terms during the user evaluation. However, this would require a localisation system to be installed at the ward which is somewhat more technically complicated than implementing the function of setting a timer.

Whether a timer (e.g. 15 minutes) of a specific time (e.g. 8.30am) should be used in the concept was also something that was investigated thoroughly. The project groups' hypothesis was concluded to be that a timer is often what is needed when a task has to be postponed because of an interruption, and therforee a timer format is what should be the most accessible when setting the reminder is time critical (like at an interruption occurs). However, when information about an activity that would take place at a specific time is received (for instance a meeting), it would often be in a planning situation where the user had a comparatively big amount of time to perform the task to set the reminder. Therforee the time alternative should be prioritised lower than timer access-wise, but still be available in the concept. This hypothesis was also confirmed at the user evaluation. Regarding which time intervals would be needed in the timer, five-minute intervals was found suitable for shorter time periods at the user evaluation, while ten minutes or more was enough for longer time periods.

Give reminder is strongly connected to the Set reminder function (above), and it is about how and

in what device the reminder should go off once the time or location is reached. It was discussed throughout the concept refinement phase, and the pros and cons of the two alternatives in MYco and in accessory respectively were carefully considered. To let the accessory give the reminder meant that it would have functionality independent from MYco so it would not be as closely connected to the smart-phone concept as if all reminders went off from the MYco device. This could be an advantage at wards where not all nurses have MYco since they would still be able to use the accessory, but the point of it being an accessory to the smartphone would be lost to some extent (and therfoore perhaps be outside the scope of the project). It was also seen as positive to use the technical functionality in MYco as much as possible in cases where it would not matter from a usability perspective if a specific function would be in the accessory or in MYco.

Not give time- or location defined reminder but only a simple note which is reasonably visible to the user all the time, and through that work as a reminder was also a function which usefulness was investigated during the phase. How little information that was needed in order for a user to detect that it was something they was supposed to remember (and also understand what it was) was discussed, and the project group thought that such a need existed. Different ways of implementing such a function in the concept were elaborated around, and some ideas were a lit diode, something showing in MYco, or depressed button on the accessory. However, during the user evaluations the nurses concluded that both of them thought they needed a triggered reminder to notice the note, so there was little of no need for just a so-called 'thread on the finger'.

Symbols for different categories of reminder types is another function which can be sorted into poten-tial core functions of the concept. The possibility of a need for symbols came into discussion when the project group was looking for a feasible way to give the reminder some kind of additional, simple identification, other than a sound clip which is not over-viewable in for instance a list of multiple reminders. To use a symbol could also be faster than writing down a note (on paper or in MYco) input-wise and it could also be more direct in its output than for instance listening to the sound recording of a reminder. In certain use situation, it could even be enough for the user to see a symbol to remember what the reminder was about and therfoore they would save time by not having to listen to the pre-

viously recorded reminder (as the principle of Clued Recall, see 2.3 Memory).

Category types: According to current theory about memory (see 2.3 Memory) it would be beneficial to use symbols that triggers visualisation and thereby helps the user to create a visual memory consisting of the symbol together with the task they want to remember. For instance, if one of the symbols would be an umbrella the nurse could visualise how the umbrella flies across the room and hands out medicine to a patient who has a rain cloud above his head. When the nurse later receives a reminder with the symbol of an umbrella, they would easier recall what the task was about, compared to a symbol that don't triggers any visualisation. A benefit from this kind of symbols would be that the same symbols could be used by everyone, independent on what kind of tasks that are common in their work. The method would require some practice though, and during the user evaluation the nurses expressed the method as a bit uncomfortable and uncertain. Other ideas for how to design the symbols was to use either strict non-symbolic signs as crosses and rectangles, or to use more situation specific symbols like a patient bed and a medicine jar. The more ab-stract symbols would increase the risk for confusing or forgetting which task that corresponds to a cer-tain symbol, but keep the possibility to use the same symbol for different tasks. Furthermore, the more situation specific symbols would limit the number of tasks allowed, or require a high number of different symbols. During the user evaluation the nurses ex-pressed positivism to task specific symbols, meaning that too abstract symbols would imply a risk of not remembering what the task was about when given the chosen symbol. It was further investigated which and how many symbols that would be appropriate aiming to include as many of the nurses daily tasks as possible, keeping a sufficient low number of dif-ferent symbols.

Set reminder in app is an alternative function to Set reminder in accessory, and whether the app alternative, the accessory alternative or a combina-tion of the two was the best solution was discussed in this phase. It should (as previously mentioned) be possible to design a product which would make it quicker to set a reminder than doing it in MYco, but it could also be useful to be able to create a remin-der directly in the app if not having access to an accessory of some reason, or if a user wants to add more/another type of information than what the accessory would allow (mainly functions described

in 7.2.2). During the user evaluation it was found that one of the interviewees would prefer to use the hardware part of the accessory, while the other would rather use a reminder concept by handling only MYco. The latter said that "I like having everything compiled in one place".

7.2.2 Additional functions

In addition to the core functions of the concept, a number of lower prioritised but still interesting functions were discussed and the pros and cons of them were weighted against each other. Below follows explanations of the considered additional functions and of the factors that influenced the design discussions in relation to each function.

Edit reminder means that if circumstances change or new information is received after that a reminder would have been set, an edit mode would allow the user to make changes within that reminder. The nurse might therforee for instance add a recording, change category, add a note and add a patient retrospectively. This function was not discussed in detail or requested during the user evaluation, but the project group could not see any reason for it not being a part of the concept anyway. It had the potential of increasing the so-called tolerance towards the system, meaning that use errors could be corrected which hopefully would, in turn, increase the perceived comfort of the user.

Discard reminder deals with the potential issue if one reminder created is not valid, or if the nurse for any reason wants to delete it. Therforee, a discard function could advantageously be integrated, which, just as the Edit reminder function would increase the tolerance of the system. This function was also explicitly sought after by the nurses in the user evaluation.

Reoccurring reminder is another additional function which could be applicable when the nurse wants to set a periodic reminder, for instance every half an hour. Tasks that are supposed to be performed several times with a certain time interval in-between each time were common, according to the user evaluation, and the function of setting reoccurring reminders was therforee requested.

Snoozing is a function meaning that the user could easily postpone the received reminder until a later point if they could not take care of the notification right away when it is firstly received. This possibility was a clear requirement from the user evaluation, where also the period of time for a snooze was discussed. Which action the user had to perform to snooze was another subject of discussion. One suggestion was to handle it in a MYco mobile application (handling the touch screen) whilst another suggestion was to start a snooze by depressing a physical button on MYco.

By using **send reminder to colleague**, the nurse would easily be able to communicate and delegate tasks that they would not be able to do themselves. This function was firstly considered to be unnecessary as well as complicated by the project group, but after speaking with nurses at the user evaluation who were very positive towards the function, the question of including it in the final concept or not had no obvious answer anymore.

The **Respond to reminder** functions is closely connected to Send reminder. If it would be possible to send reminders, there would probably be necessary to include a Respond function as well, meaning that the colleague nurse could either accept or decline to taking care a reminder.

Reminders erased when log out is another function which was discussed during the user evaluation. It appeared that the nurses only wanted to reach their own reminders themselves, provided that they did not decide to send them to a colleague. Therfore the nurses suggested that all reminders created during a shift would be erased when the shift was finished, and this was something the project group continued to elaborate around during the reminding parts of the phase.

7.3 Physical product

Following from the functions specification (see 6.2) of the concept were fulfulling the requirements on the physical product. Also results from the field study (see Chapter 4) and the concept development served as input to the development of the hardware, as well as other factors which are described in detail in this section. What led to the hardware-related design decisions is also explained below.

7.3.1 Physical Ergonomics

In order to reach a result which fits nurses' bodily attributes, an adaption of the design to relevant physical ergonomics factors was done. The evaluation was executed through use of a number of methods for ergonomics evaluation.

The first one was the creation of clay models in full-scale of some different variants of the physical product (see picture 7.3.1a). Some of these models were brought to the evaluation with users to be discussed and assessed for the purpose of the project group to gain insights it the advantages and drawbacks concerning the physical ergonomics of each product variant. Continuous hand sketching to create 2D representations of the product was also done to gain insights about the ergonomics properties of different product ideas. In addition to that, 3D-printed models (rapid prototyped – see picture 7.3.1b) were created from CAD models as a method to investigate and refine the shape of the product as a last step before the design was set.

Picture 7.3.1b: Rapid prototyped model

Picture 7.3.1a: Clay models

Format

The physical product needed to be easily and quickly accessible in order to function as an effective accessory to MYco. What format the device would have was therforee central to specify for the project group to get an optimal result in terms of ergonomics. It was concluded from the user evaluation that the device needed to be placed on the nurse's scrubs in some way so it would stay securely fastened and not be dropped when the user leans over something or moves around. Therforee a clip on one side of the product was seen as a feasible way to attach it to clothes. Many different formats were considered which could be divided into two main groups; a square-like small box, and a taller pen-like product. See picture 7.3.1c below for some example sketches within the two groups.

It was seen as an advantage to make the device small in order for it to fit in the often already filled pockets of a nurse's scrubs. If it would be placed somewhere else on the clothes, for instance in the neckline, if would also preferably be relatively small to not be in the way when the user moves around.

Some setting would be needed for the user to make on the device for it to collect enough information at each interaction. Because of the need for settings to be made, a square-like shape was elaborated around since it would be advantageous to grip considered its small size. It was however also concluded by the project group that it was a necessity to design a product which the user would look at when interacting with. Of that reason, a quick reachability for picking up the product was needed, which lead the design process towards the track of a pen-like shape that could fit in the breast pocket of scrubs next to other pens which are commonly carried in that way. The round profile of a pen was also considered suitable to use when the nurse would make a setting of a graded scale, such as a timer. The long and thin format would also be practical to use as a microphone since it fits well into one hand of a user and can easily be directed upwards towards the mouth. Furthermore, there was also more room for the components needed within a pen-shape, than within a small box.

For the product to have categorisation of reminders with the use of symbols, this setting had to be enabled in some way in the design. Since the setting of reminder operation has to be quick, this feature was explored in the refinement phase. Below in

picture 7.3.1d follows some illustrations of ideas for how to set a category. If sound recording was to be a function in the final concept, a combination function of one button to be both for recording and categorisation was found suitable. If each button had its own category, only one step of interaction would be needed from the user to both categorise a reminder and recording the associated sound. To physically interact with one specific button for each category would also be something that helps a user to remember the set reminder in a beneficial way, as explained in chapter 2. Theory.

How a timer could be set on the product was another possible requirement for the design to fulfil. Early in the development phase of a reminder product it was settled by the project group that no countdown function was needed in the accessory since the users only required to know get the reminder once the time or timer had passed, and have little or no interest in easily knowing how much time that is left until the reminder goes off. However, because of time-saving reasons it would be useful to eliminate the setting operation of a time in a certain use situation if the desired time/timer was identical to the previous one. For instance, if nurses always wants to set the reminder on 15 minutes, they would not have to do it each time they is setting a reminder but just the first time using the device.

Below (picture 7.3.1e) follows some idea sketches on different ways to integrate a graded scale that were discussed throughout the concept refinement. As mentioned earlier, a knob or handle of some kind is advantageous to use when having a graded scale, and it is also relatively easy to solve technically than many of the other alternatives discussed. A way for the hands stay relatively close to their natural positions (See Chapter 2. Theory) when doing the time setting is to rotate two ends of a pen-like shape in relation to each other, maximising the griping surface of the relatively small object. The user can also easily re-adjust its own grip whenever reaching an uncomfortable rotating angle. The diameter of the shape would be relatively small if it should not take up too much space, but since the resistance in the torque required to move along the scale would be very small, it would not be a problem even with a very thin handle.

Picture 7.3.1c: Sketches of square and tall format

Picture 7.3.1d: Sketches of how to set a category

Picture 7.3.1e: Sketches of how to integrate a graded scale

Measures

The measures of the physical product were based on evaluations of what would fit the majority of Swedish nurses' hands. From the percentage women working as nurses combined with values of table 2.4.1 in section 2.4.1, the measures of a 5-, 50- and 95-percentile nurse would be calculated, see table 7.3.1.

The hands of the project group members were then measured to get a picture of how big approximately the hands of the future users of the product would be compared to the hands which would try out the measures. One group member had a hand similar to a 5-percentile nurse (170 mm length and 69 mm breath) and the other group member's hand was substantially larger than those of a 95-percentile nurse (194 and 91 mm for length and breadth respectively). Because of this, it was concluded that the project group combined would not miss out any important factors when evaluation the size of the physical product by using their own hands.

The length of the product if being in pen-format would need to be long enough for it to stay safe in the pocket of the scrubs and to be handled comfortably when in use. However, it should not be longer than the clip to fit in a scrubs pocket which is 140 mm deep. A feasible length was decided upon by trying out the rapid-prototyped model shown in picture 7.3.1b. When it comes to breath of the product, no great torque would be needed (as previously mentioned), and therforee it was seen as advantageous of space-reasons to have a relatively thin profile. Therforee the fitting of components required inside the product was limiting the breath (see section 7.3.3 and 8.2.3 Technical function in the Results chapter). After the first 3D printed model was tried out, the length was adjusted to being slightly longer. Examples of a small hand trying out the model is seen in picture 7.3.1f.

Also the details of the physical product were evaluated by handling the printed model, and a couple of new iterations with printing rapid prototyped models and adjusting the shape were done to ensure a good refinement. The measures as well as placement of the buttons were tested, and also the radii, size and shape of the clip which was also thereafter slightly changed from the original model.

Visibility of information

When it comes to the size of the icons and digits of the physical product, the project group decided to generally follow the guidelines for small screens presented in the Theory chapter, section 2.4.2 Sight and Visibility. (This is also valid for the text sizes of the interface, see 7.4.) An own complementary evaluation of the digit sizes was also performed to get a picture of how big the different sizes were in real-life, see picture 7.3.1h.

	Women		Men		Nurse
Hand length					
5-perc.	0,9 * 159	+	0,1*173	=	**160,4**
50-perc.	0,9 * 174	+	0,1*189	=	**175,5**
95-perc.	0,9 * 189	+	0,1*205	=	**190,6**
Hand breath (metacarpal)					
5-perc.	0,9 * 69	+	0,1*178	=	**69,9**
50-perc.	0,9 * 76	+	0,1*87	=	**77,1**
95-perc.	0,9 * 83	+	0,1*95	=	**84,2**

Table 7.3.1: Hand sizes (mm)
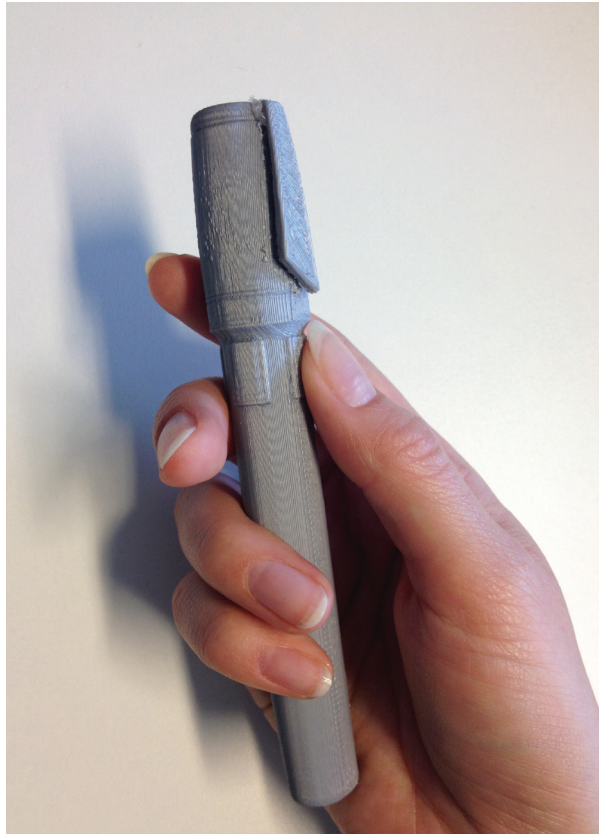
Picture 7.3.1f: Small hand holding model

|	
Give med. 00.12.02	Helvetica Size 5
Give med. 00.12.02	Helvetica Size 6
Give med. 00.12.02	Helvetica Size 7
Give med. 00.12.02	Helvetica Size 8
Give med. 00.12.02	Helvetica Size 9
Give med. 00.12.02	Helvetica Size 10
Give med. 00.12.02	Helvetica Size 11
Give med. 00.12.02	Helvetica Size 12

Picture 7.3.1g: Font sizes

7.3.2 Form

The expression of the physical product was another aspect which was interesting for the project to take into consideration when refining the concept. The formal requirements were stated as that the product should fit within the company's current product portfolio in a comparable way as MYco does, and also work well with the MYco industrial design.

Concerning method, the first one used was hand sketching which continued throughout the concept development- and refinement phases. In addition to that, digital sketching in Adobe Illustrator was done in the early phases of the form development. See picture 7.3.2a for some examples of different product expressions elaborated around here. Also the clay modelling that was done as a preparation for the evaluation with users was a step in the form process, and even though the formal expression was not explicitly evaluated by the users, the formal expression of the product was explored with clay by the project group at this point. Before taking on the digital modelling (CAD) in Alias Automotive and 3D printing of the model (See previous section 6.3.1), a form development session in Catia V5 Imagine and Shape was conducted to gain a quick overview of the expression in 3D digital environment.
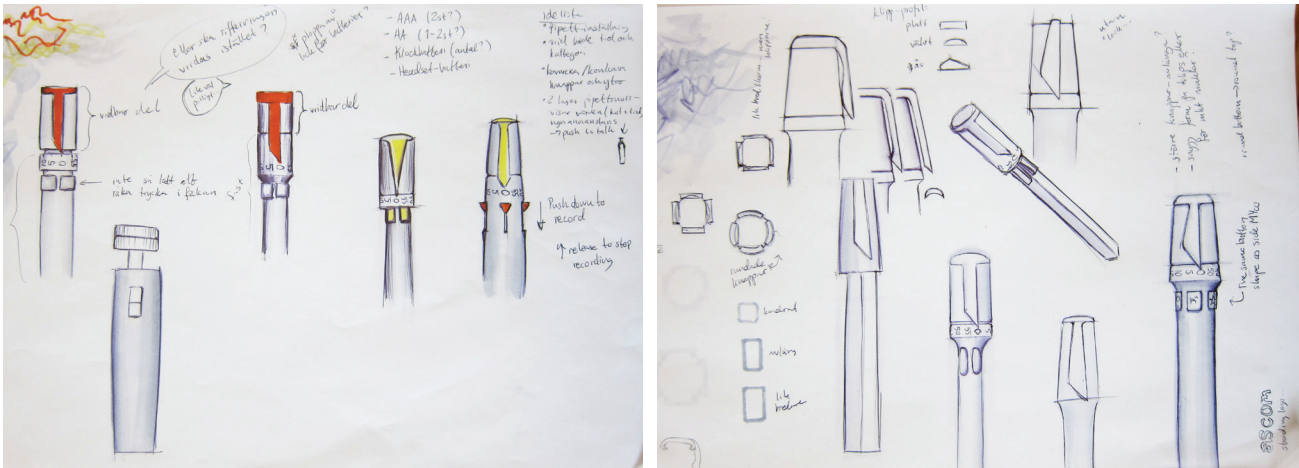
Picture 7.3.2a: Form design sketches

Picture 7.3.2b: Ascom's characteristic ID elements

Ascom's visual brand

The company has highly developed internal material about their product expression characteristics and also about what formal elements that have created the desired expression in the past and current products. Therforee, the project group decided not to do any own investigation of the design format of the company's product portfolio but use the existing material. Consequently, the information source of this section is internal company material and therforee the specific references are not given.

Ascom wants to be a premium brand and have a timeless product expression. Details and craftsmanship are important and focus is often put on the top surface of a product since the most crucial functions of its mission critical communication is operated from there. Reoccurring form elements in the past products are a round bottom line, standing logotype, contrasting colours, curved shapes on surfaces, a relief logo and recessed functional elements. Ascoms own representation of this is shown in picture 7.3.2b.

MYco's expression

As previously mentioned, the MYco concept and handset is under development in parallel to this thesis project. The industrial design (from here on called ID) is not finalised at the point in time where this report is written, but the project group has seen the latest proposal (may 2013) and has designed the accessory product with the MYco design in mind. However, of confidentiality reasons, the MYco ID cannot be fully explained or shown in this report. What can be said about it though is that several form elements that has been common in the company's products in the past are reoccurring also in the MYco design, especially the curved shapes on a surface. The MYco's design is supposed to express that it is Professional, Reliable and Serene, and it is essentially the same product expression that should be valid for the physical accessory product too.

Form of accessory

The MYco concept keywords Professional, Reliable and Serene are all equally important also in the accessory, since it has to do with the user relying on the product to do as it promises, to remind them at the time when the user needs it. The concept should however be serene in its behaviour, and not draw attention to anything which is not required for it

to function. Also an expression of professionalism is important considering the user will carry it with them all day, use it possibly frequently in their everyday work and carry it relatively visible for patients as well as colleagues to see.

It was concluded that an analogue product expression was suitable for the products since it should give the impression of being quick and easy to use. The form development was to a relatively high extent function-driven, aiming at communicating it is a functional object. However, it was also desired to have some kind of identification detail, something that could indicate it is something special and not just an ordinary object. For both of these formal ideas, the Ascom historic design format elements as well as similarities to the MYco design was used in the design of the accessory.

Nevertheless, since understanding of each function at first glance was not needed (hence the learnability was more important than guessability), the project group worked with highlighting the Set timer function form-wise in relation to other functions. The reason for that was to empower the product's analogy to an egg clock or a similar product which deals with giving reminders of something after a certain time has elapsed. A form where which matches the user's mental model of an egg clock is a mean for communicating this core function.

7.3.3 Technical specifications

The technical specification of the physical product was done by oral interviews and discussion with various experts within the different fields working at the company. In general, it was seen as advantageous to be able to be able to benefit from the existing technologies and manufacturing techniques that the company already has, and this was therforee the main guideline for the technical specification.

To get a brief insight into the how the company manufactures its products today, a visit to the factory in Herrljunga was conducted. At this site, the low-volume products are assembled, while the high-volume products are produced in other factories in Thailand and China. The plastic parts are ordered from suppliers, while most of the circuit boards are built from components in the Herrljunga factory. This would practically make it possible for the concept product to be produced with whatever materials and methods required, but of cost reasons it would be beneficial to do it as simple and as possible and

if applicable, use the same methods and materials as today.

It was identified by an LCA done by the company and quoted in a Bachelor thesis project (Bratt et.al, 2012) that 86% of the environmental impact the company's products has today is due to the energy consumption during use, and of this reason the battery type of the concept was carefully investigated. The battery had to be small enough to fit into the product in a feasible way, while also lasting long enough for the product to be practical. Also the charging/exchanging of batteries was an important factor, as well as the cost of the solution.

To power the device, three different kind of batteries were evaluated; Li-ion, clock battery and AAA batteries. It was important that the battery type chosen should be able to power all components within the device, the size had to be convenient, the environmental impact minimised, the life length maximised and cost held down. To make the evaluation more reliable, personnel at Ascom with competence within electronics were used as support.

A clock battery would have the advantage of being small and cheap, although not as powerful as the other two solutions, i.e. not last as long. It was also questionable if the power supply would be enough

for running all components. The AAA battery is more powerful than a clock battery, but has a greater size. Also it would have to be recharged relatively often and requires an external charger or a storage of spare single-use batteries. Another disadvantage was the environmental affect, which is higher than the other battery alternatives. Li-Ion batteries are used in most electronic devices of today, for instance mobile phones, earphones and headsets. They are more expansive than the other solutions, but last longer and are easily rechargeable through mini USB.

To make sure that all components would fit into the suggested form, a component analysis was made. By taking help from experts at the company, a circuit board with all necessary components could be sketched up. As seen on picture 7.3.3 the components would fit in all dimensions, with extra margin in length.

Also a rough economical estimation was made regarding the components, by calculating the indicative single cost for each component. The price for the different components varied between 1 and 20 SEK, which ensured that the combined component cost would not be excessively high.

7.4 Interface

In parallel with the development of the physical product, the development of the interface in an application for MYco (a so-called mobile app) was done. The app is supposed to serve as the connection of the physical product with MYco, and the design decisions of this development are described and motivated in this section. They build mainly on the Field studies (see Chapter 4), the functions specification (see 7.2) and theory about Gestalt (see 2.2.3) and Usable Design (see 2.2.4). Also the development of a clickable test application for a mobile phone was constructed, which is described below in section 7.4.2.

7.4.1 Interface design

When all functions were set, sketches of wireframes were drawn on a whiteboard (see picture 7.4.1). This facilitated the process of deciding how all functions were to be integrated into the interface, also rapid changes in how the functions were connected could be done efficiency. Decisions about which functions that would be included, and in which order
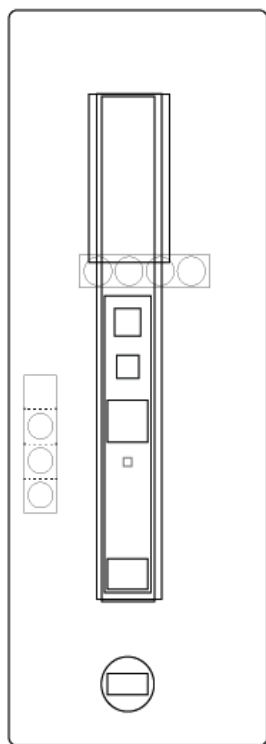
Picture 7.4.3: Components in product

they should appear were taken with consideration to usability guidelines. (Chapter 2.) For instance the number of different choices on one single page was not allowed to exceed five. Also the placement of arrows and other navigation buttons was set to match the mental model of how to navigate through digital menus; placing backwards at the left side, whilst confirm and forward was placed on the right side.

As the placement of all functions on each frame was determined, a digital interface could be developed. While transforming to a digital format, decisions about which text size had to be taken.

7.4.2 Test application development

To make it possible for evaluating the interface as a whole (see Chapter 9), digital wireframes describing a stripped down interface were created. The wireframes were formed with focus on functions and features, i.e. the content. No effort was put on making a graphic design at this point, since that might have made the users rate the graphic design instead of the functions in the user evaluation. The graphical design should also be coherent with the MYco concept app design, and therforee it was not considered in detail within the project.

The frames were linked to each other through a software called Hype, making HTML code out of flash animations. A clickable test application for smartphones (hereafter called the MEMco test application) was then developed through another computer software called Phonegap, transforming HTML code into an Objective-c code (used for creating mobile phone applications). The reason for why a mobile application was created was to make sure that the user tests were as authentic as possible. Instead of testing the interface on a computer screen, the nurse could now use a device much more similar to the real product.

The actions clickable in the digital interface were matched to the user test tasks, meaning that all actions visually described in the interface were not clickable. Nevertheless, it was assumed that a sufficient amount of actions were accessible for making the test credible.
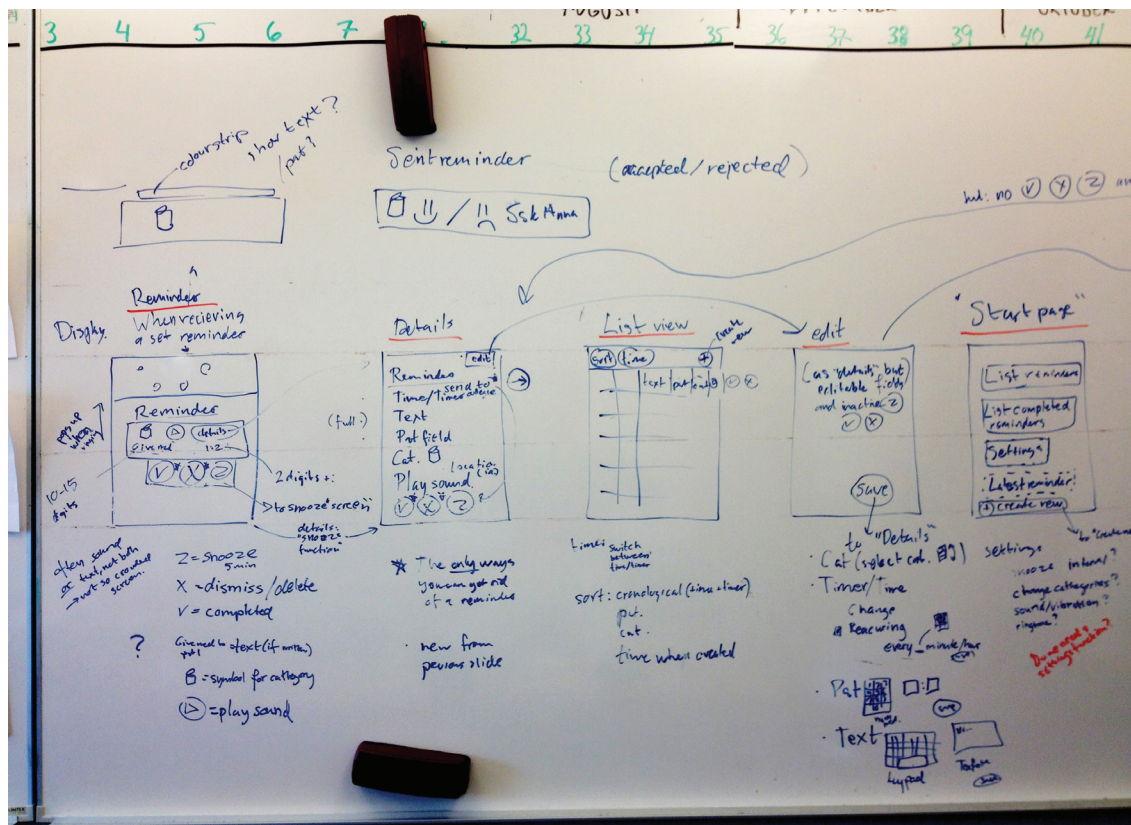
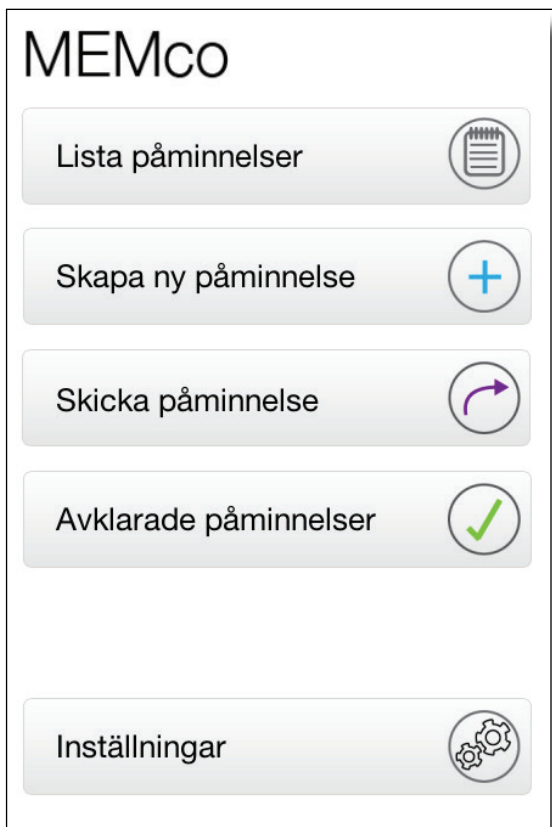*Picture 7.4.1: Whiteboard sketch of wireframe*

8. Result

This chapter describes the design result of the project. It is divided into an introducing section called 8.1 MEMco, followed by the in-depth describing sections 8.2 Use, 8.3 Hardware and 8.4 Software.

Picture 8.1a: the MEMco device

Picture 8.1b: the MEMco application

8.1 MEMco

The result of this master thesis project is called MEMco. It is a design in the format of an accessory to the MYco concept (a healthcare smartphone), and it consists of a set of functions which are enabled through the use of an external physical product and a mobile application in the smartphone. The physical product can be seen in picture 8.1a and the mobile application in picture 8.1b.

MEMco aims at minimising the negative consequences of interruptions that nurses at hospital wards experience in their everyday work, by providing memory assistance for tasks that are otherwise easily forgotten. If the nurses' work becomes more efficient, also the patients being treated by the nurses could, in turn, benefit from MEMco through an increased comfort and feeling of security.

The concept name MYco stands for "My own co-worker", "companion" or "co-pilot", and the reason to why the design of this project is called MEMco is that it is closely connected to MYco, but also deals with memory assistance.

MEMco is a hybrid of a voice recorder and a timer which also has an easily accessible categorisation of reminders. The physical product is 120 mm high, round in its profile and 20 mm thick, making it similar in size to an ordinary pen. It has a clip for easy fastening on clothes and in pockets, 4 buttons with different symbols for categories printed on them and a graded scale along the circumference around which the top can be twisted to set a timer. At the bottom is a hatch hiding a USB charging connection and at the top there is a microphone with a small, central hole in the shell. The product mainly comprises of three plastic parts, four buttons and a number of electrical components that are further described in section 8.3.3.

The physical product sends information to the mobile application in an associated MYco smartphone via Bluetooth. A reminder can be created either through use of the physical product or directly in the mobile application and consists of a categorisation, a sound clip and/or a set timer. Additional information can also be added if the mobile app is used. Once the set time of the timer has run out, a discrete alarm goes off in the MYco device, reminding the user of their task.

8.2 Use

To use the MEMco system, a MYco smartphone is required which will be carried in a pocket of the scrubs worn by a nurse working in a hospital ward. MEMco's physical product is comparably small and quick to use compared to picking up a MYco for the same purpose, and a MEMco can be carried for instance in the breast pocket next to the other pens a nurse often has placed there.

A sound is recorded in a similar way as a Dictaphone with a recording starting when a button is depressed, and stopping when the same button is released. The user can through this record audio notes to themselves to listen to at a latter occasion, for instance "give a glass of water to the patient in bed 3:1". However, the MEMco product has four different recording buttons, each with a situation-specific symbol on them. The user chooses one of the four symbols for a category to "record under" and through that they also automatically gives the system some information about the subject of the reminder. The user can also choose not to record any sound but only depress and then release the button, and then the reminder consists only of a symbol.

To set a timer to the reminder, the upper end of the MEMco device is rotated until the clip points at the desired time. X on the scale means that no time is set, but when this is used the reminder is still transferred to MYco and put up on the list of reminders in the application, even though no reminder notification will appear. The product does not rotate while the countdown goes on which enables the function of several simultaneously on-going reminders. A rotating countdown function would be redundant since the user does not need the function of "how long time is it left until my reminder goes off?" to be easily accessible. The purpose of setting this type of reminder timer is that the user should not have to think about the task at all until they gets the reminder notification. It will however be possible to see the time left until a reminder will go off in the mobile application. The non-rotating head also enables the possibility for the user not to change the set time between setting one reminder and the next. This means that if they have for instance a standard time of 10 minutes which is most commonly used, the user will not have to change the time when creating a new reminder and a step in the action chain is thereby eliminated.

If the mobile app is used instead of the physical product to set a reminder, a categorisation and/or a timer is selected in the application through the function "create new reminder" (see 8.4). Also a sound clip can be recorded directly in the app through use of the phone's own microphone.

When the time of a set timer is up, the reminder goes off by playing a sound and/or vibrating and showing a notification on the small external display of MYco, which will display the symbol for the chosen category. Since the user has previously chosen and looked at the symbol while setting the reminder, an association has probably been created between the task and the symbol of the reminder category. If the user then remembers the task by getting a memory clue through seeing the symbol, that might be enough information needed in that situation and the potential sound clip can be left unheard. The reminder can instantly be checked or snoozed by the user by a tap on one of MYco's external buttons.

If the user does not remember what task it was by watching the symbol on the external screen, they can click on the reminder which has popped up on the phone's main screen to reach the detailed view and then listen to the recorded sound in the phone. Also all optional additional information (see 8.4) that has been added by the user to the reminder is accessed from this view on the main screen. At the bottom of the screen are also buttons for snooze, check and discard the reminder.

8.2.1 System design

The idea to MEMco came from the insight that there is a clear need for an active function which gives a reminder of a task that needs to be performed, something that is more than just an easily forgotten "mental note" or a note on a paper. The biggest challenge in such a product would be how such a note could be created in an easy way. It should preferably be as fast and simple as possible since the nature of nurses' work is very reactive and the need for a note with reminder is often created in a situation where an interruption occurs. To create reminders for the less common event type that are planned in advance (typically meetings) however is mainly not very time critical and the user then has more time and can use an app to create the reminder. These are the ideas that formed the basis for the design; a selection of a category and a voice recording was perceived as an advantageous combination, where

Picture 8.2b: Nurse with a MEMco device in the breast pocket of her scrubs

the two information types completes each other in terms of quickness and flexibility.

It is a great strength of the design that each individual user can decide themselves if and when they want to use the physical product and/or only the application to create the reminder. However, the fact that the handling is sped up to such a big extent by using the physical product compared to setting a reminder in MYco motivates the extra item to be bought as well as carried around for the user. To pick up, push a button, speak and release the button (as the action chain is for using the physical product) is much quicker than picking up the bigger MYco, selection the application in the menu, select "create new reminder" press "record", speak and press "end recording". If a time is set or no sound clip is recorded but just a time, the length in action chains differ even greater. The existence of the physical product is also expected to increase the use of the concept since the alternative to using the physical product in many cases is expected to be not using it at all (and not to pick up MYco to do it) since the procedure could be perceived too time consuming.

MEMco is supposed to be used for tasks where it is not too important exactly when they are executed, that they do get done approximately after a certain time interval is the main issue. Therforee the point-in-time when a reminder is produced was concluded to be more time-critical than that of giving a reminder. Of this reason, the reminder is given in MYco, which also already has a purpose-built system for notifying its user about alarms and other events. By using MYco's own technology for giving the reminder, the technology in the MEMco device can be kept relatively simple, not needing for instance a digital memory, a clock or a bigger battery. To give the reminder in MYco was therforee seen as the technically (and through that economically) optimal solution.

8.2.2 Symbols

The symbols have been developed with the most common tasks in mind that a service like MEMco would be used for according to the user evaluation (see 7.1). Such actions could be for instance meetings, to give medication, take a blood sample, call a relative, move a patient bed or ask a patient something, tasks which could all be sorted into the categories symbolised in picture 8.2.2a, b and c. The reason why the buttons are 4 in numbers is partially of cognitive reasons. It is said in memory theory

(see section 2.3) that 5 chunks (+/-2) are what the human mind can take in and handle simultaneously, and since the user will need to quickly choose a category when creating a reminder, more categories would have meant a tougher and therforee slower choice.

Three of the symbols are all related to different kinds of tasks nurses have in their everyday job, and the forth symbol is a star which could be "other", "important" or something else the nurse would like to use it for. It is however not important that the individual perception of what each category can contain is consistent between different nurses since the symbols will first and foremost be used to remind the user of their own association to the category. Therforee it is even an advantage that the developed symbols can mean different things to different users, because that means that the system is flexible and adaptable to the specific task types of each ward- and user type who uses the MEMco system.

8.3 Hardware

This section describes and motivates the properties that are directly related to the physical product of MEMco, being form design, physical ergonomics, the technical function, its connection to MYco and practical aspects of implementation at a ward.

8.3.1 Physical ergonomics

The physical product of MEMco is designed to be easy and quick to use, and therforee the physical ergonomics aspects have been of highest importance in the design work. To combine record- and categorisation function into the same buttons minimises the time required to set a reminder in the often time-critical situation. The thin and long pen-like format fits easily into the users pocket without taking up too much space, and provides convenient grip surfaces when taken out of the pocket and used to twist the time setting into desired mode. The shape of the product is also similar to a microphone enabling one-hand grip, and any recording button can be depressed with the thumb while the product is directed towards the mouth and spoken into.

The size and placement of digits and symbols is adjusted to be visible enough for the user to see easily. Also the overall size of the product is based on tests with a physical 3D-printed model (see picture 8.3.1)
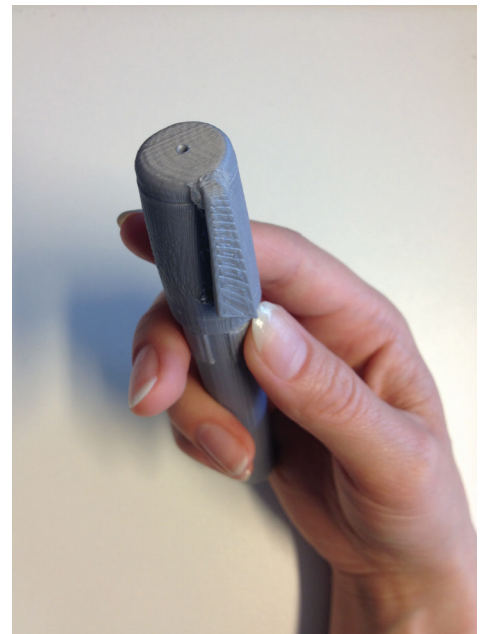
Pitcture 8.2.2a: The MEMco device

Pitcture 8.2.2c: The four symbols

Pitcture 8.2.2b: Symbols on the MEMco device

Pitcture 8.3.1: Printed prototype

and with nurses' hand sizes in mind. The length also fits well into the Swedish nurses' breast pocket on the standard scrubs.

The number of buttons being 4 is not only of cognitive reasons, but also physical. It would be a real challenge to fit more buttons than 4 on the product taking into account they all have to be easy to press, big enough for larger fingers and the radii is relatively small. To have buttons in two or more rows would be problematic since a lower button at one side would easily get accidentally depressed if the user tries to press a button in the upper row on the opposite side. All buttons also have to be protected somehow in the shape from getting accidentally pressed while the product is in place in the user's pocket. The main reason for the broader profile right above the buttons is this, to prevent accidental recording.

8.3.2 Form and semantics

The MEMco product (seen in picture 8.3.2) is supposed to look simple, functional and purpose built yet attractive. MYco's design expression is (as mentioned in 7.3.2) supposed to be "Professional, Reliable and Serene", and this is also what should be and is communicated by the MEMco product design. The professionalism is maintained through the simple and functional design, and it expresses reliability through having the core functions visible and easily accessible. Since the product is relatively discrete in form and details and cannot play sounds or disturb the user in any other way, it will also likely be seen as serene. As the product is of a completely new type and not something the user is familiar with, the intention of giving the user the impression of a purpose-built product is not easily fulfilled since the first-time users will most likely not know the purpose of the product at first glance. Nevertheless, once they have understood what the product is for, the function will correlate with the product expression.

The design of the product is also supposed to fit the company's product portfolio and does so through use of many of the historically common form elements. Some examples are curved shapes on surfaces such as the profile between the buttons and clip tip, slightly pumped surfaces, a standing logo and contrasting colours.

The format and size of the product gives a strong analogy to a pen, which is intended since it suits the
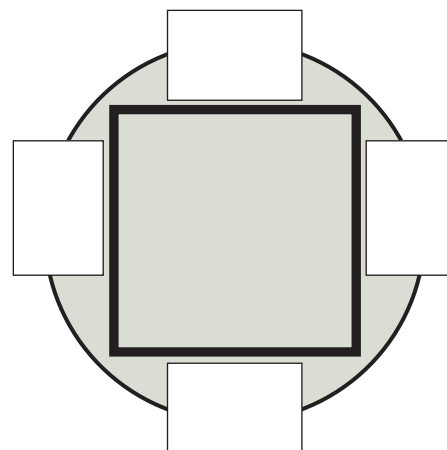
purpose of making mental notes to oneself very well. The learnability of the product (telling the user it is not an ordinary pen) is also more important than the guessability of the same since the vast majority of the user interactions will not be with a first-time user.

The MEMco device has an element which gives it a unique identity among other pen-like objects, being the asymmetric clip. Through the design the clip is put in focus and it has a similar expression as the MYco concept device has, making it fit and signalling "it works together with MYco". The clip is also used as pointer to signal that its tip is an important action point for the function, hence should not be bent or broken. This detail is necessary to have for the product to function, and if it is broken, the MEMco will fall out of the pocket and the overall function will be lost anyway.

There is a small risk that some users will try to detach the top of the product as they would do with an ordinary pen since the product is similar to one. It is however mainly first-time users that will do this and the construction of the product with an encoder connecting the upper- and the lower part will be durable enough to sustain such treatment.
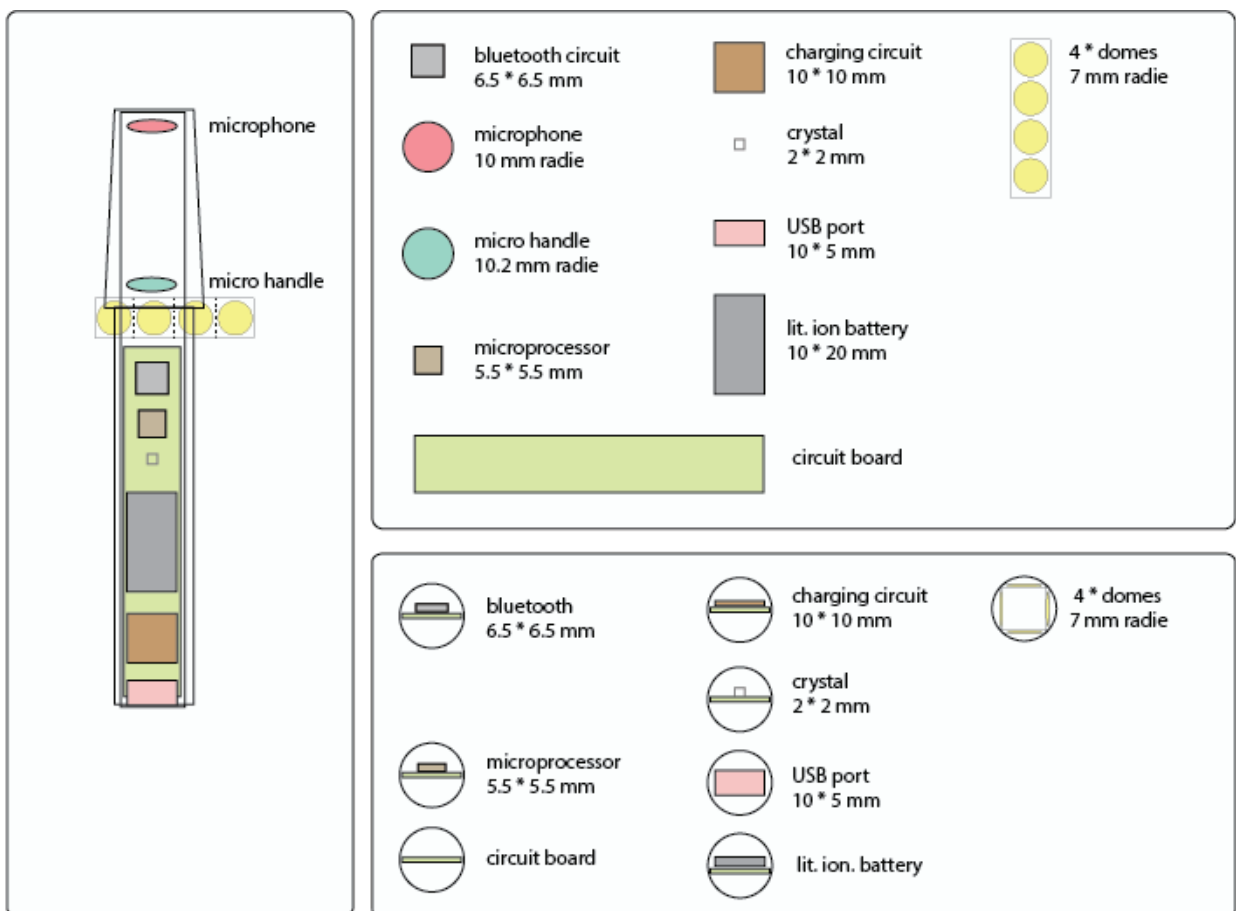
8.3.3 Technical function

Inside the shell, the MEMco device contains several electronic components which are attached to a circuit board, see picture 8.3.3a. Those components are a charging circuit, a microphone, an encoder (micro handle), a microprocessor, a lit-ion battery, a USB charging port and a Bluetooth circuit. Also four

Pitcture 8.3.3b: Illustration of domes

Pitcture 8.3.2: Form of the MEMco device

microphone

micro handle

bluetooth circuit 6.5 * 6.5 mm	charging circuit 10 * 10 mm	4 * domes 7 mm radie
microphone 10 mm radie	crystal 2 * 2 mm	
micro handle 10.2 mm radie	USB port 10 * 5 mm	
microprocessor 5.5 * 5.5 mm	lit. ion battery 10 * 20 mm	

circuit board

bluetooth 6.5 * 6.5 mm	charging circuit 10 * 10 mm	4 * domes 7 mm radie
	crystal 2 * 2 mm	
microprocessor 5.5 * 5.5 mm	USB port 10 * 5 mm	
circuit board	lit. ion. battery	

Pitcture 8.3.3a: Circuit board

domes are fastened on a soft circuit board, which enables the domes to point out in four different directions. (picture 8.3.3b)

A charging circuit is necessary to charge the lit-ion battery through the USB port. All other units are powered by the lit- ion battery, which is placed in the bottom close to the charging circuit. To charge the device, it is connected to an USB charger.

The micro handle transforms the analogous time setting triggered at the top of the MEMco device into a digital signal which is sent to the microprocessor.

When a category button is depressed, the dome underneath it creates a digital signal which indicates the corresponding category, and the dome also triggers a recording to start in the microphone and sustain as long as it is depressed. The microphone records the voice and transmits it to the microprocessor.

8.3.4 Connection with MYco

By transferring information through Bluetooth to MYco, everything that is recorded in the device is directly accessible in the mobile application. This enables the function in the application of adding or changing information after the first recording. When a reminder is created through the device, the microprocessor processes the information given from the microphone, the time handle and the chosen category button. The length of the audio clip, the content of the audio clip, the category and the time set are transferred to MYco through the Bluetooth circuit. In the application a new reminder will be created with the same features as the one set in the device. No information is saved in the MEMco device, why it is necessary to keep it close enough (<10 m.) to the phone in order for the transmission to function properly.

8.3.5 Practical implementation

Purchase

When purchasing MEMco, it is important that the buyer is aware of that MEMco is not functional without a MYco smart phone, as MYco is needed to save and display the reminders recorded. MEMco will be delivered together with descriptions of how to use it, although to facilitate the understanding of the product and its system, it would be suitable if a short separate introduction were given to the user, preferably in connection with the set up of the MYco and MEMco system.

It will be possible to purchase only one or a few MEMco to one ward, since the system is not dependent of other MEMcos to work properly. Also it would be possible to have only the application installed, although it would imply a slower procedure when recording, which will take the edge off the concept and is therforee not recommended as a first choice but a complement by the project group.

In addition to MEMco, other accessories could be relevant as well; a safety strap, individual category stickers and clips in different colours to ease the identification. However, the relevance and user need of those accessories has to be further examined.

Charging

The device is charged through USB, meaning it could be connected to a computer's USB port, or an adapter with an USB gate. Assuming normal use, the estimated time between two charges is about one week. While charging the device it is not suitable for use, since it would require either the user to stay by the computer or the power source to be movable. The time until the device is charged is estimated to two hours, which implies that the device could easily be charged during a less intense period, or during the night shift when there are less nurses and thereby all devices may not be occupied.

Maintenance

Likewise all hospital equipment, there are laws regulating what electronic devices must resist regarding chemical detergents and how cleanable they need to be. The material used for the shell of MEMco should fulfil those requirements, and since the materials are said to be the same as for MYco, those would be approved.

Also, since the device is supposed to be used by different personnel from shift to shift, it is particularly important to protect the users from bacteria. This has been taken into consideration when designing the shell. The device has as little unnecessary corners and split lines as possible, which will facilitate cleaning. Since it is a hand held device and therfore continuously will have contact with human skin, its shape allows wiping without dirt that gets stuck in

for instance split lines. The area with greatest risk for dirt is the one underneath the clip, but that is also the spot with the least physical human contact.

A high level of reparability and a long life cycle are both important selling points for the company as advantageous environmentally, and therforee essential parts have to be replaceable or possible to repair; the clip hat, additional category buttons and electronics are such examples. By keeping storage of those parts, it will be possible for the company to deliver spare parts or repair devices being sent in.

8.4 Software

This section describes the mobile app part of MEMco. The software developed is an application with the functionality of both handling existing reminders and creating new ones. The application is as previously mentioned connected with the MEMco device through Bluetooth, making each reminder created by the device instantly viewable and editable in the application. Taking into account the product will be used in an environment with high and tough tempo, the visual clarity of the application is of high priority. The interface is therforee simplistic and clean, with a relative large type (between 12pt and 16pt), and focus has been to design both clear and descriptive symbols.

There are two editions of the interface, one adapted for testing the application, made in black and white, without design elements that might affect the evaluation of the functionality, and one second edition (visualised below) with both symbols in colour and discrete design elements such as gradients on the buttons. The specifications and content of the application is determined within the project, all though final software development in form of programming has not been completed.

8.4.1 Functions of the Application

Main menu

When the application is started for the first time by a nurse during a shift, the main menu is shown. (picture 8.4.1a) Next time the application opens, the user will see the same page as when the application was used the last time. From the main menu screen the user can navigate to list view, create a new

reminder, send a reminder, see a list of all reminders completed during the shift and change preferences in settings.

Create new reminder

It is possible to create a new reminder not only through the MEMco device, but also directly in the application. The user presses "create new reminder" in main menu and a screen shows, looking like a detailed view but containing no information, see picture 8.4.1b. There are four thumbs of category symbols, and the one relevant is chosen by clicking and then it gets a bold frame. It is always possible to change symbol, by clicking on one of the other symbols, which are still there but without the bold frame. Underneath the symbols, the time is managed. If the time button is pressed, the user can choose between set a time interval and a specific time. The time setting is optional and if no time is chosen, the reminder will still be saved but without expiration time. Also the time is possible to change by clicking on the frame displaying time again. Under the time button there is a space for notes, in which the nurse can write additional information in the same way as when editing a reminder. When clicked, a keyboard will show on the screen up allowing the nurse to write. Below is the patient field, which when pressed will display a list of the current patients applicable for the nurse, which makes the list more overviewable than if all patients at the ward would show up. By clicking on one of the patients, it's moved to the patient field, which means no further writing is required.

At last, there is a button for an optional sound recording, which is performed by clicking on the voice recorder button. To stop the recording the nurse presses the button once more. If the user wants to create a new voice recording, they just click on voice recording again, which will overwrite the first recording. By pressing Save in the upper right corner, the reminder will be shown, and could thereafter be displayed in the list view.

Settings

Through settings (picture 8.4.1c) it is possible to set preferences regarding snooze time, type of alarm notification (sound, vibration or both) and language. Also the categories could be changed here if the default categories are not suitable for the user's individual working area, something that had been pointed out as a potential need in the user evaluation. Howe-

ver, a change in categories in the application would require a corresponding change of symbols on the buttons of the physical MEMco device if they were to be used together.

List view

In list view, all reminders created within the current shift are shown. As seen on picture 8.4.1.d the symbol for each reminder is visible, together with notes or a specific patient number. To the right the time left until the reminder goes off is displayed. The user could choose whether the reminders should be sorted according to category or time, with time as the default choice. By clicking on a reminder, the user reaches a new screen with details about this reminder.

Detailed view

In the detailed view (picture 8.4.1e) the user can, in addition to reading the same things as in list view, also play the voice-recording which has been previously recorded by clicking on the play button. To navigate between the different reminders directly in detailed view the arrows above the edit button is used. For returning to list view the arrow in the upper left corner is pressed. In the bottom of the screen the action buttons snooze, delete, send and check the reminder are available. The symbols for send and check are the same as in the main menu for keeping the inner consistency of the system, and thereby enhance the recognition and learnability of the system.

When the snooze button is pressed, the symbol for snooze will be shown in fullscreen, together with the time predefined as snooze time. After about a second, the application will return to list view, and five more minutes (the snooze time) have been added to the count down for the actual reminder. When pressing the action buttons delete or check, the corresponding symbols will firstly be shown in fullscreen as visual feedback, and 0.5 seconds later the action will be performed.

Edit a reminder

If anything needs to be edited, the user reaches edit mode through the edit button in the upper right corner, in detailed view. When pressed, the user reaches edit view (picture 8.4.1f) and has the possibility to change category, add a written note or a patient number to the reminder, delete or record a voice re-

cording. When the user is done, they presses save for saving the changes and do then automatically return to the detailed view. If a mistake has been made, the back arrow may be pressed for leaving the edit mode without saving.

Sending a reminder

From either the main menu, or from a specific reminder, the send reminder page can be reached (picture 8.4.1g). If it is reached through the main menu, the user firstly has to choose which reminder that are about to be sent. When this has been selected the user presses the send button, a list of people that the user can send the reminder to will appear. At this page (picture 8.4.1h) the receiver of the reminder is chosen, which is done by clicking on either the name or the picture of the desired nurse person. The box will then move to the right, illustrating the reminder being sent away. After one second the main menu will appear. The user will thereafter get a notification as soon as the person receiving the reminder has either accepted, rejected or not replied the reminder. As long as a reminder has not yet been accepted by the receiving person, it will stay in the sending user's application and go off in the original device even if the user has previously tried to send it. This is if security reasons, to ensure that no reminders get lost.
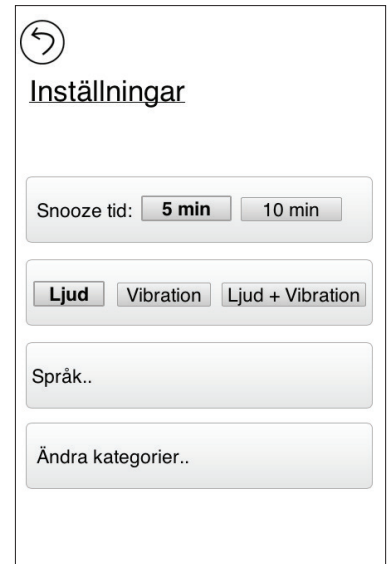
Completed reminders

When pressing on completed reminders in the main menu, a screen with all reminders either completed or sent to another person will show (picture 8.4.1i). This function is intended to be used primarily during the handover and before leaving a shift, to remind the nurse about what has been completed and if there is something that may be worth telling the nurse taking over the responsibility for the patients concerned by the tasks that have been performed during the shift. The user should also be able to partially or fully empty this list if and whenever they wish to, for instance before handing over the phone device to a colleague taking over after a shift.
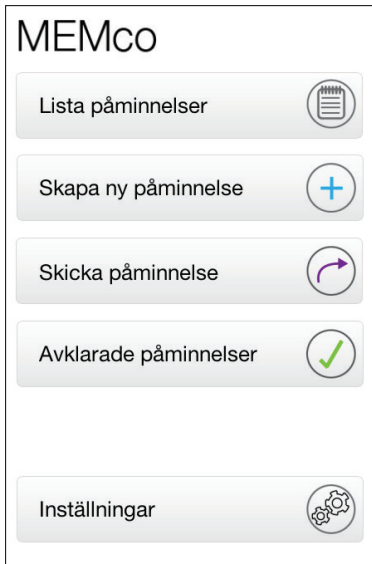
Pitcture 8.4.1a: Main menu
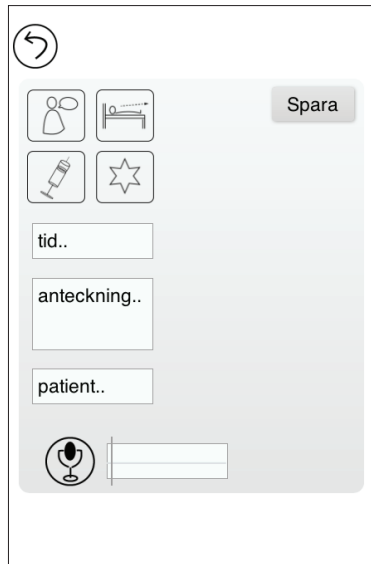
Pitcture 8.4.1b: New reminder

Pitcture 8.4.1c: Settings

Pitcture 8.4.1d: List reminders
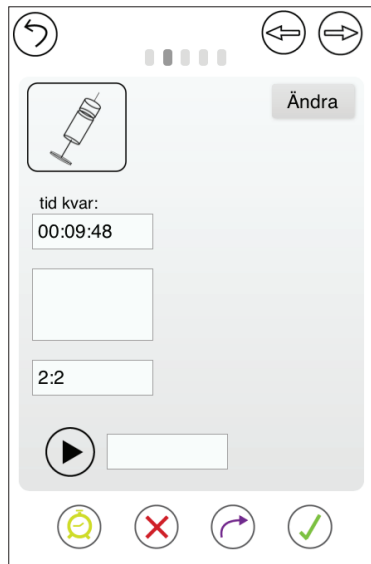
Pitcture 8.4.1e: Detailed view
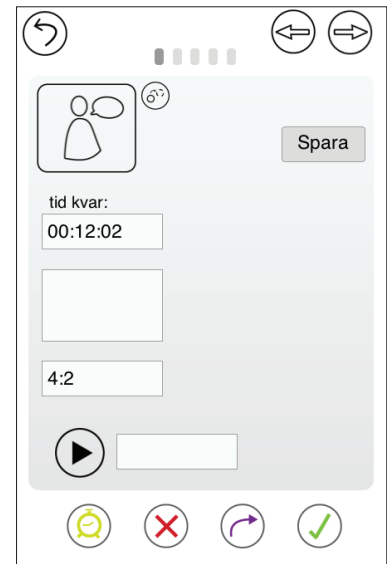
Pitcture 8.4.1f: Edit view
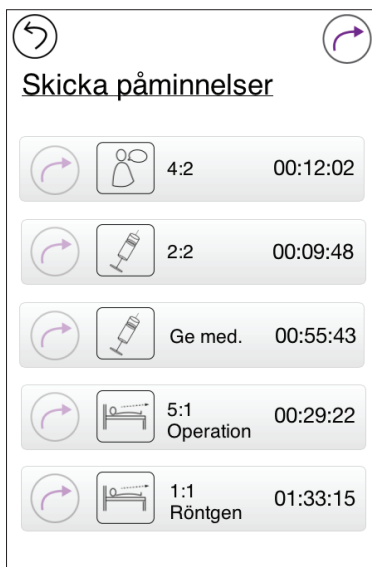
Pitcture 8.4.1g: Send reminder I
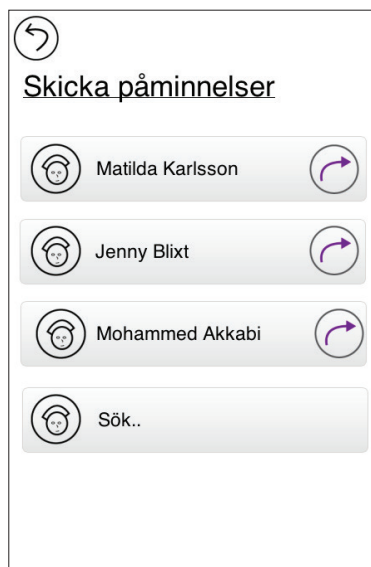
Pitcture 8.4.1h: Send reminder II
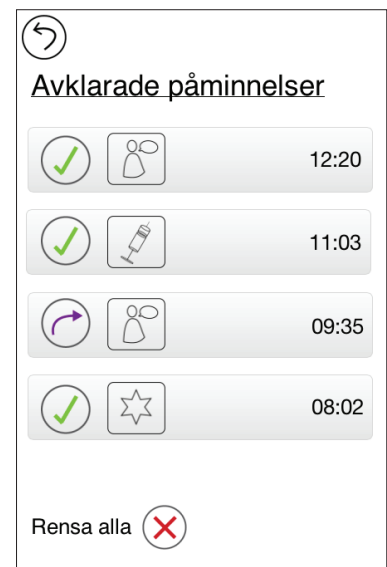
Pitcture 8.4.1i: Completed reminders

9. Validation

Evaluating the final result gave important insights regarding recommendations for further development. The evaluation was divided into five different parts; symbols, physical ergonomics, visual expression, the interface and the concept as a whole.

9.1 Methods and process

The evaluation was a mixture of both a semi structured interviews and a usability test, since parts like visual expression were more suitable for discussion while other parts, like the interface were better evaluated through a test. Three hospitals were visited, Östra Sjukhuset, Uddevalla Sjukhus and Kungälvs Sjukhus, and in total there were five nurses participating in the evaluation. Two of the nurses had not been involved previously in the field study or evaluation sessions, why a lighter introduction to the project was needed.

After the concept had been explained, the nurses were shown the symbols representing the categories described here in chapter 8. Result. The nurses were then asked if they understood the symbols, and what kind of tasks they would have put within each category. Also, they were asked if the number of categories were sufficient, or if they wanted to add or remove any category.

The second part regarded physical ergonomics, meaning evaluation of the handheld device. The participants got a non-functional prototype printed in 3D handed to them and were asked to rotate the upper part, press a button and simulate a dictation. Photos of how they hold the device were taken, and the nurses responded to questions about their perceived accuracy of size and proportions. (See picture 9.1)

When the participants had seen and tested the prototype they received simple printed renderings of the CAD-model, and were asked questions about the visual formal expression, according to both the prototype (shape) and the renderings (shape and color).

Picture 9.1: Hands trying non-funtional model

Before evaluating the interface, the nurses were given a smartphone with touch screen and the MYco test application installed. The participants had the possibility to quickly look and click through the menus, to make sure they understood how to navigate in the application (especially for participants not being used to touch interfaces on phones). The evaluation consisted of six different tasks:

1. Sort the list of all reminders according to time

2. Create a new reminder where you have to take a blood sample on patient 2:2 in ten minutes

3. Listen to a reminder regarding patient 5:1

4. Change the preset snooze time to 10 minutes

5. Create a new reminder where you are about to go to a meeting at 15:00

6. Choose one or several reminders to any colleague

The interface was black and white, with as little of design elements as possible, to make sure the nurses evaluated the functions and placements of buttons rather than the design. One reason to why the tasks in the test were specified was to determine within which of the four categories the nurses choose to put them, as they would have done in a real user environment. Also, by repeating two similar tasks (2 and 4) the short-term learnability could be evaluated to some extent.

Finally, the concept as whole and its functions were evaluated. This was made through an open discussion about the added value of the concept, if it would solve an actual problem and what they thought the design could be used for. Also whether they would prefer to use either the application or the product was asked, or if that would depend on each situation. Further, the nurses responded to which of the two ways to set a reminder they thought different colleagues would prefer to use.

Another subject for discussion was however if they and their colleagues would feel comfortable with speaking into the device, or if they rather would use the text function to write down notes digitally.

9.2 Result

9.2.1 Symbol evaluation

The result from the symbol evaluation showed that the nurses had a similar view upon what the symbols and categories could be used for. Also, the answers matched the project group's thoughts and believes to a high extent. One thing notable was that the star was said to be used for either "other things" or "important things", which would imply a difference in usage. See also table 9.2.1.

9.2.2 Physical evaluation

The size of MEMco was perceived as suitable for all nurses involved in the evaluation, and also the size of and distances between buttons were said to be comfortable. "It's nice, that it is this small" was one among the comments regarding the overall size of the physical product.

Regarding the placement, MEMco was said to be carried in the breast pocket of the scrubs, although it has to compete about this space with pens and note blocks.

One nurse said they would feel safe to have a security strap around MEMco, referring to the device as something expensive to repair if dropped and broken.

9.2.3 Interface evaluation

All participants did manage all tasks at a minimum level of attempts, except one nurse who in the last task repeatedly pressed on the label "send reminder", which was a heading and therforee not clickable. All tasks performed were executed without any external help.

During the first evaluation, there were comments from the participants regarding that they would have preferred Swedish above English as the application language, so this was therforee changed until the second and third evaluation. Also one of the nurses during the first evaluation had a problem reading all content due to its size, which resulted in an increased size of those text elements prior the second evaluation.

Since the number of attempts before solving the task was close to minimum for all tasks, no increased efficiency in managing similar tasks could be seen during the test. Thus the learnability of the interface could not be measured, but since the guessability apparently had a sufficient level the lack of measurements upon learnability was not seen as a problem.
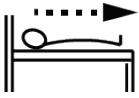
	Anything with drugs Give medicine. Used during night shifts when alone, for blood, antibiotics etceteras.
	Move patient. Discharge patient. (Move patient to) X-ray Wake up patient. Everything regarding a patient. Questions and stuff regarding patient.
	Make a call. To call relatives. Meetings. Something needed to be said or written down. Inform patient about upcoming exams, planning for discarge etc.
	Important stuff. Other things. "I might put everything here." For instance: care planning, check blood pressure. For other stuff, individual.

Table 9.2.1: Various meanings of the symbols, as expressed by validation nurses

9.2.4 System design evaluation

Regarding the concept as a whole, some recommendations for further development were received. One of the most frequent comments were that it would be nice to enable reminders not only when the time ran out, but sometimes 10 minutes before the set time, for instance when going to a meeting or sending a patient to x-ray at a specific time.

Another thing that would need further consideration is having not only the time span next to the reminders in the list in the application, but also possibility to see the specific time set for it. This was said to facilitate the understanding for when a reminder was about to go off, although it would occupy space affecting other content.

It was also discussed what would happen with the reminders when a shift is over and the nurse hands over their MYco to the nurse at the next shift. Some nurses said that they would like everything to be removed automatically, while others said it would be a good idea if they could easily transfer tasks to the nurse at the next shift. One function that received very much positive feedback, was the possibility to send reminders to colleagues, and some interviewees though it would be more readable than their manual notes.

Additional acclaimed requirements were to insert an erase button for each reminder as well as for all reminders, and the possibility to choose which kind of reminder the receiving college would get (silent, vibration or sound).

None of the intervieweed thought there would be a problem to record reminders in front of the patients, since the assumed information would not be that sensitive; "you wouldn't say very strange things, and for instance 'dressing wounds for 2:2 at 15:00' would not be a problem saying in front of a patient." Nevertheless, one of the nurses though voice recordings would not be used to a high extent, since there are no such tradition among nurses.

Other quotes from the nurses validating MEMco:

"Are we going to get this?" "This feels great! And patient safe!"

"Much easier to read things here than to read my handwritten notes"

"I could definitely use the application right away if I go outside this room and start working."

10. Discussion

The project described in this report has been a rather unique one to the project group, not only because it has been the biggest one so far in scale, but also because it has raised a great personal engagement for the design users in question. Throughout the project the group members have dug into the working conditions of nurses through everything from interviews, personal visits at wards and full-shift observations, to debate articles raising voices about the acute need for more personnel within Swedish healthcare. Through all this, the project group has gained a deep understanding and sympathy for how great every-day heroes the nurses are. They do always try their best to give the patients care and comfort, and this insight has been a big source of motivation to work hard with the design project to ensure a good result that has the potential of easing the nurses' workload and make the job they are going to do more efficient. This engagement has definitely also contributed to the quality and as well as level-of-detail in the design result.

This discussion will address how the project process as well as the final result complies with the goals and priorities that were stated at the beginning of the project (see Chapter 1. Introduction). It will also clarify what factors that influenced the compliance and describe some lessons learned along the way. The chapter is divided into 10.1 Methods and process, and 10.2. Result. The conclusion focusing on answering the research questions of the project can be found in the final Chapter 11. Conclusion.

10.1 Methods and process

The gathering of theory information took place twice, first as an initial phase regarding the hospital environment, and secondly during the idea generation phase to enhance the knowledge primarily about how the human memory works. This second theory study was not specified in the project plan, since it was not clear which area the final concept would comprise of when the project commenced. Although that part was not in the original planning, it came to take an important part of the development, and influenced the final result to a major extent.

Another action which came to take up more time than planned during the project was to perform the various visits to the users. In the user study, the hardest part was to manage all visits during such a short period as planned, since practically all wards contacted were largely occupied at the time of the field study. It was not too complicated to get hold of nurses at suitable wards in the first place but some of the wards contacted were unable to receive a visit even though they were very positive towards the project. Still many already planned visits were cancelled with short notice, mainly due to sudden changes in work load at the wards, and several wards had to cancel even the same day as a visit was planned. The cancellations resulted in a prolonged user study phase, as it was important to gather a sufficient amount data to be able to make decisions upon knowledge rather than assumptions. The repeated cancellations were the obstacle that alone created the greatest delays according to the project plan, and as a result the initial idea generation phase had to be shortened with approximately a week. It would however probably not been possible to schedule the visits for the field study earlier in the project to speed up the completion of that phase since the reason was not lack of planning but the unpredictable environment a hospital ward is. The following user visits in the refinement- and validation phases were however planned simultaneously with a comparably high number of wards, something that minimised the need for backup plans in especially the last validation phase. It is hard to tell how much the delays affected the final result, although the shortened idea generation phase may have had a negative impact on the number of initial ideas. Still it felt like both the amount and quality of these ideas were high enough to make a decision about proceeding.

In the idea generation- and concept development phases, focus was alternated between two different areas, the patients' experience and memory assistance. This was something that was seen as highly positive for the process since having two parallel focus areas eased the brainstorming work in such a way that whenever reaching a feeling of "getting stuck" within one field, there was always a possibility to shift focus for a while into the other area. One could also think a step further and think about how the areas could be combined, and that also stimulated the creativity and fostered even more outside-the-box ideas. One of the main argument for continuing with two different areas was that that it decreased the risk of getting caught in a dead-end with only one idea. Further it gave the company a possibility to discover a broader field of future accessory areas, even though it stood clear that only one solution would be more developed than the others in this project. The decision about keeping two different tracks quite a long time in the concept development phase possibly made the final result a bit less specified than if only one track would have been chosen. When to make the critical path decisions is a recurrent question that each product development project has to deal with, but as the final result turned out the project group thinks the chosen strategy was a good one, and it also made it possible to present more than only one identified further product need to the company, although the concepts regarding patients' experience were much less worked through.

At the end of the concept development phase, a concept combination of two concepts within the area of memory assistance was chosen for further development, discarding the remaining two concepts within the area along with the concepts within the patients' experience area. The choice to prioritise the Memory area over Patients area should not be seen as a prioritising of the severity of the problems within the areas but merely a question of feasibility to the project's scope. The nature of the concepts as a potential accessory to the MYco spoke in favour of solving the memory-related problems, something that the company representatives also expressed. The solution type to the Patients' experience problems was also predicted to require extensive IT system integrations in order to fulfil the strongest needs within the area (those about patient wanting overviewable information and plans), something that would have required the focus in the remaining part of the project to be on how to solve this integration technically and legally rather than on service- and

product design. Furthermore, as a consequence of the system integration needed, the time perspective of the concepts when it comes to realisability also differed with the Memory assistance concepts closer in time than the more long-term Patients' experience concepts. The correlation between a strong need and a relatively easy implementable solution which matched the project scope was the strongest within memory assistance, and therforee a concept within the area was chosen to be further developed. In the end, the project team believes that the chosen track enabled a much more developed final result, since the result not only matched the project scope but also the competence within the project group.

10.2 Result

One of the four major focus areas that were stated in the beginning of the project was to promote a comparably high level of innovation and novelty of the design solution. This has been done both by doing an unconditional and extensive field study, by using several different idea generation methods and techniques, and also by involving people with many different perspectives in the ideation process (nurses, interaction designers, mechanical engineers, fellow students, etc.). The result of the project is a completely new product that does not as far as the group members know of exists yet, and it is the projects group's belief that it proves that the novelty in innovation has been sufficient.

The first discussion topic related to the novelty focus is that firstly and foremost central in the project has been the service- and function design (since this is a completely new product development project). Therefore areas like details, form- and graphic design have been addressed only to a lower extent, which in turn has led to that the product expression of both the product and the app has some additional work to be done before it can be seen as completed. Regarding the mobile application it is of course suitable to match the interface against other parts of the MYco interface, something that during the project was limited due to current development by the company.

An aspect that made this project rather unique as a design development project was the combination of the open-ended target of a high level of innovation and novelty, and that the result should simultaneously fit into the scope of being an accessory to

MYco, being developed in a contemporary project. The open-ended phases at the beginning of the project was therfore almost a prerequisite for the second part to result in something useful since the accessory-related limitations had to come in once a concept was formed, and they could limit the design to a rather high extent. This combination of novelty and an accessory was however an interesting challenge which spoke to the creativity of the project group and once the full understanding of the task had been reached the combined requirements made the project even more engaging.

The last topic related to the novelty focus is that despite the fact that a concept within memory assistance makes up the final design result of the project, the concept also to some extent seeks to solve some problems detected within the area of Patients' experience, namely the patients' needs of feeling seen, listened too and remembered by the nurses. A contributing factor to this is the fact that the two areas were ideated around in parallel in the idea generation phase which demonstrates that the Patients' experience was as previously mentioned not completely disregarded even in the final design result MEMco.

The second major focus area of the project was to maximise the user benefits of the design result by having continuous contact with the intended users, and this also proved to be a very advantageous when it comes to fulfilling one of the goals of the project; to fulfil one or several of the main needs of nurses. Even though it took some time and effort from the group members to be able to meet the always-busy nurses the project aimed at assisting, it was a great advantage to the final result that they were involved to such a high extent throughout the whole process. To receive both input, feedback as well as ideas from even a small number of users but continuously (in interviews, observations, surveys, evaluations and validations) instead of just in the beginning of the project (as the case often is for a typical design project) has been both fun and highly valuable, and it is something that the project group would like to recommend designers to do if having the chance. The user approach is without doubt one of the main reasons why the final concept was recieved in such positive terms in the user evaluation. It is of course however also important to remember to not always simply "do as the user says" but try to figure out what they really want, need and mean when the users are express their views not only on problem identification but also about solution design to the problems. This has been a skill the project group

members have had the chance to practice in this project, and an experience to learn a great deal from.

Another aspect of fulfilling nurses needs by MEMco is that it has the potential of not only easing the every-day stress and cognitive work required of the users, but also in the long-term reduce general workload and give the nurses more time to do what both they and the patients wish they could do more, namely to speak with each other.

The third area selected for focus when the project commenced was to ensure the market- and profit potential as well as the technological viability for the company. This was intended to be done though a close dialogue as well as cooperation with various company representatives throughout the whole process, and this is also something what has worked very well and undoubtedly affected the result in a positive direction. The project group has had continuous supervision from the company with meetings at least once a week, great support with information as well as project strategy, and also various work material at disposal of the group members. The fact that the project has to a large extent been carried out on site at the company's office in Gothenburg has enabled the many short yet informing meetings with various internal experts. This has led to the project taking in a large amount of information along the way and through that becoming very accurate and realistic even for being a Master Thesis project.

The access to a lot of information and people at the company has also facilitated the second and third goal of the project to be reached, being to ensure a technologically realisable and economically beneficial result, and also to match the final design to the company's product portfolio, respectively. The cost of the final design has not been closely investigated since it is a conceptual design, but since all components are relatively cheap, it is manufactured from simple materials and simple and standard technology is used, the cost of the product is assumed not to exceed the added the value the use of it will give. Exactly how the value should be measured economically is something that needs further investigation. If it should be proven that MEMco significantly decreases the risk that a nurse for instance forgets to send a patient to surgery at a specific time, the cost for MEMco would be earned multiple times and create an additional great markering advance. Except for economic values, the relation between nurses and patients hopefully could be improved by MEMco. This since MEMco will offer nurses a tool for

remembering the little things, as informing relatives about small treatment changes or bringing water to a patient. Hopefully the patients' then will trust more in the nurses and feel more confident, which will imrove their relation.

When it comes to the third goal, to match the final design to the company's product portfolio, it has as mentioned before not been a prime focus of the project to work with form, but since the design has several of the commonly used formal elements in the portfolio and also that MEMco is proved to suit well into the MYco concept function-wise, the project group regards it to match the product portfolio.

The last focus area of the project was decided to be to enhance the environmental sustainability of the design by making the final solution as durable (considering function as well as aesthetics) and repairable as possible, hence making a good product that will last for a long time. This is also connected to fulfilling the goal of maximising the durability of the design itself over time. Since the MEMco is concluded to be attractive to the users in the concept validation, and the project group thinks the project process has ensured a well thought-through product that is physically durable (when it comes to the device), this goal can be regarded as reached. If the users choose to use only the application part of the design, the environmental impact of the MEMco use will be even lower.

Lastly, how the distribution of which nurses that want to use the device, the mobile application or a combination looks like obviously has to be further investigated. The project group has identified needs for both the device and the application, although how the needs vary among different hospitals, wards, tasks, ages etceteras needs a much broader study then the one perfomed in this project. A broad study would give the company useful information about how to brand the two parts of MEMco differently, and if the device might be unneccessary for some wards. Even if some nurses will find the application more useful, the project group is confident that the device brings important values to the MEMco concept. Not only because of the reduced time it means for creating a reminder, but also the simplicity it brings to the service, regardless of previous technological knowledge. This was somewhat shown by the concept validation where the nurse with the highest age and lowest technological experience appreciated the device the most.

11. Conclusion

The Master Thesis project "Additional equipment to nurses' communications system" has been executed in cooperation with Ascom Wireless Solutions and the design MEMco is the outcome of the project. MEMco is the result of a new product- and service development consisting of a physical product and a mobile application. It is an accessory to the company's smartphone concept MYco and it aims at assisting nurses at hospital wards to remember every-day tasks through setting reminders with timers in a quick and user-friendly way. MEMco is a completely new invention assuring the novelty of the project, and also realisable technically by the company with relatively small means.

Which the most common/important/severe problems are that arise for nurses related to communication was investigated in the field study of the project (Chapter 4). Many problems were evidentially related to lack of financial resources within healthcare, but some potential improvement areas were identified within which consequences of strained hospital budgets could be mitigated in one way or another through use of a design. The problem areas that had the best potential of being eased through an accessory of some kind were the patients' experience along with memory assistance for nurses, and a final concept was the developed mainly based on the former problem area. MEMco (described in chapter 8. Result) is thus an answer to the research questions about how problems related to nurses' mental workload can be eased by a design, and also how it can be done as an accessory to the smartphone concept. When the design had been developed, a final validation of MEMco followed which gave generally very positive results, so the last question about how well the result fulfil the requirements of its intended users (detailed result in chapter 9. Validation) has also been answered.

The design has not only been seen as attractive to the intended users, but also to company representatives having a market- perspective. MEMco is clearly integrated with the MYco concept and adds value to it by utilising the functions the smartphone concept has and improving parts of its functionality through an optional, additional physical product. The purpose of the project has through this been fulfilled.

It has been fun to work with new product development, valuable to have such close cooperation with the company and greatly engaging to design for nurses. The project group is very pleased with the design result, and hope and think that its future users will find it useful.

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Appendices

Appendix 1: Nurse interview

Intervju-mall sjuksköterska

Avdelning: På:

M/K:

Inledning

Position?

Hur länge har du jobbat som..?

Hur många jobbar på avdelningen?

Hur många patienter (vanligvis)?

Hur långa skift?

Hur många patienter har du hand om?

Jobbar ni i par/grupp/individuellt?

Kommunikationssystem

Vad har ni för olika kommunikationssystem idag?

… model/er?

Vilka använder du? Vad använder du den till?

Hur bär du den? Tappar den den ofta?

Arbete

Beskriv kortfattat en typisk arbetsdag:

Hur ofta får du ett larm? Hur tar du emot det?

Svarar alltid? Varför?

Olika typer av larm, är det svårt att skilja på dem? Hur agerar du vid osäkerhet?

Hur för du journal? Hur läser du journalen?

Överlämning..? Vanliga problem? Tid?

Hur samlar du in information under ronden när ni går runt till patienterna? Hur lagras informationen? Analogt/digitalt? Egna anteckningar? Gemensamt system för anteckningar?

Blir du ofta avbruten i en arbetsuppgifter för att en annan kräver uppmärksam-
het? Hur går det att återgå till den första uppgiften sen? Hur minns du var du
gjorde innan avbrottet?

Vilken information hade du helst haft tillgänglig hela tiden? (som du inte kan
komma ihåg)

 = Vilken typ av information skrivs upp i handen/på lappar?

Kommunikation

Hur kommunicerar sjuksköterskor med varann?

Hur hittar personal varandra? Hur ofta/efter hur lång tid ger ni upp? Hur gör
ni då?

Hur kommunicerar sjuksköterskor med patient (och vice versa?)

Vad pratar (patient-sjuksköterska) mest om? Varför?

Vad skulle du helst vilja prata med patienter om?

Hur kommer ni ihåg vad ni pratat om med en patient? (Om ämnen som inte är
direkt relaterat till sjukdomsbild/journal) Om/Hur delas sådan info med andra
sköterskor?

Pratar ni med patient om tiden efter sjukhusvistelsen? Hur?

Vad fungerar bra? Varför?

Vad fungerar mindre bra? Varför?

Vad vill du lägga mindre tid på? Varför?

Vad vill du lägga mer tid på? Varför?

Vad saknar du med dagens kommunikationssystem? Varför?

Beskriv en vanlig kommunikationssvårighet? Vad blir (kan bli) konsekvenserna
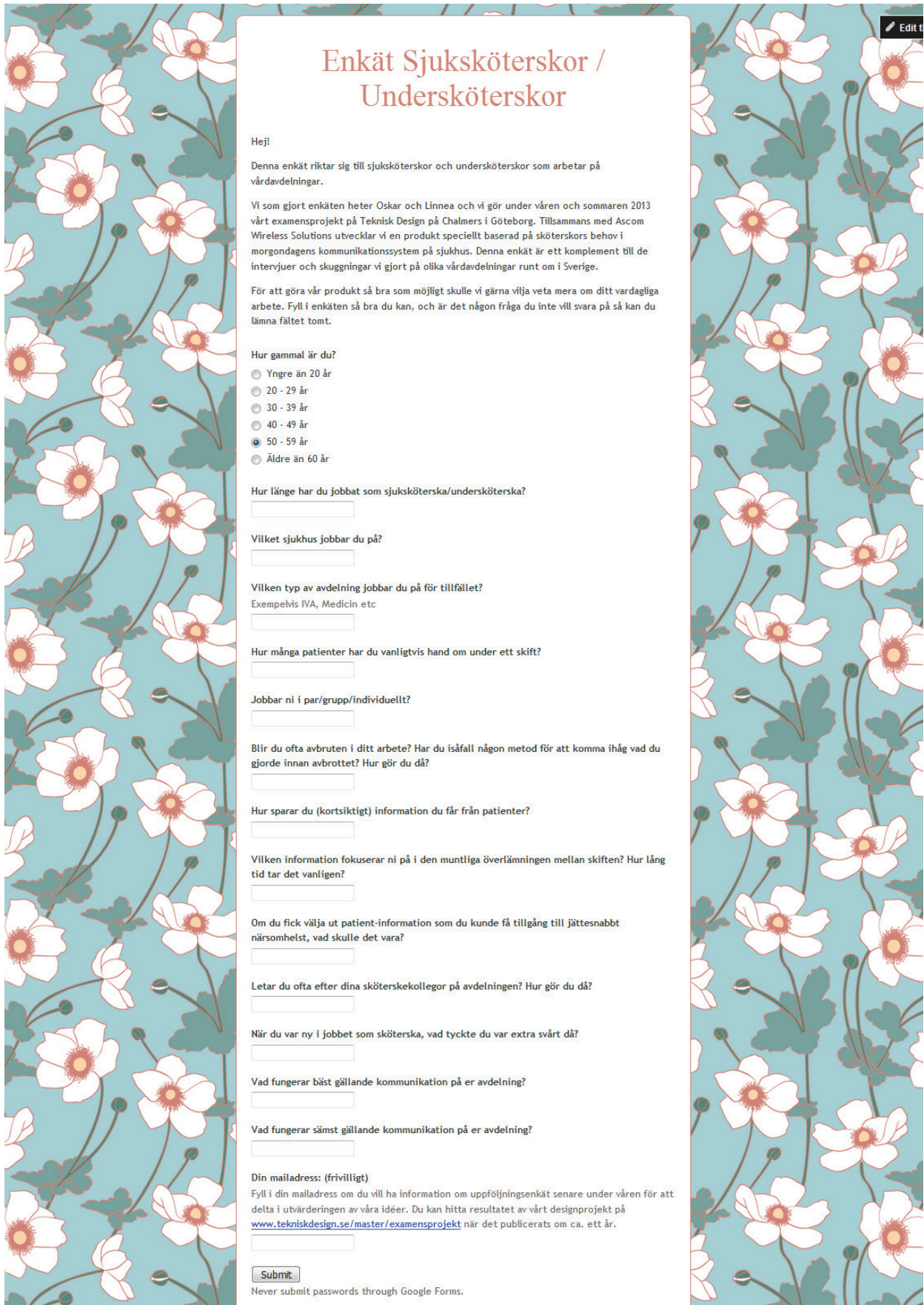av en sådan svårighet?

Avslutning

Vad är det roligaste med ditt jobb? Varför?

M/K:	Ålder: <20	20-30	30-40	40-50
50-60	60+			

Tack!

Appendix 2: Survey Nurse

Enkät Sjuksköterskor / Undersköterskor

Hej!

Denna enkät riktar sig till sjuksköterskor och undersköterskor som arbetar på vårdavdelningar.

Vi som gjort enkäten heter Oskar och Linnea och vi gör under våren och sommaren 2013 vårt examensprojekt på Teknisk Design på Chalmers i Göteborg. Tillsammans med Ascom Wireless Solutions utvecklar vi en produkt speciellt baserad på sköterskors behov i morgondagens kommunikationssystem på sjukhus. Denna enkät är ett komplement till de intervjuer och skuggningar vi gjort på olika vårdavdelningar runt om i Sverige.

För att göra vår produkt så bra som möjligt skulle vi gärna vilja veta mera om ditt vardagliga arbete. Fyll i enkäten så bra du kan, och är det någon fråga du inte vill svara på så kan du lämna fältet tomt.

Hur gammal är du?
- ○ Yngre än 20 år
- ○ 20 - 29 år
- ○ 30 - 39 år
- ○ 40 - 49 år
- ● 50 - 59 år
- ○ Äldre än 60 år

Hur länge har du jobbat som sjuksköterska/undersköterska?

Vilket sjukhus jobbar du på?

Vilken typ av avdelning jobbar du på för tillfället?
Exempelvis IVA, Medicin etc

Hur många patienter har du vanligtvis hand om under ett skift?

Jobbar ni i par/grupp/individuellt?

Blir du ofta avbruten i ditt arbete? Har du isåfall någon metod för att komma ihåg vad du gjorde innan avbrottet? Hur gör du då?

Hur sparar du (kortsiktigt) information du får från patienter?

Vilken information fokuserar ni på i den muntliga överlämningen mellan skiften? Hur lång tid tar det vanligen?

Om du fick välja ut patient-information som du kunde få tillgång till jättesnabbt närsomhelst, vad skulle det vara?

Letar du ofta efter dina sköterskekollegor på avdelningen? Hur gör du då?

När du var ny i jobbet som sköterska, vad tyckte du var extra svårt då?

Vad fungerar bäst gällande kommunikation på er avdelning?

Vad fungerar sämst gällande kommunikation på er avdelning?

Din mailadress: (frivilligt)
Fyll i din mailadress om du vill ha information om uppföljningsenkät senare under våren för att delta i utvärderingen av våra idéer. Du kan hitta resultatet av vårt designprojekt på www.tekniskdesign.se/master/examensprojekt när det publicerats om ca. ett år.

Submit
Never submit passwords through Google Forms.

Appendix 3: Survey Patient

Enkät Patienter

Hej!

Denna enkät riktar sig till personer som någon gång under det senaste året har legat på en vårdavdelning på ett sjukhus.

Om du är sjuksköterska eller undersköterska får du gärna göra denna enkät istället:
https://docs.google.com/forms/d/1yTLVnCgVjv_c9zAYxGMlz89kdNluEmLzzGPq-2_rp0Y/viewform

Vi som gjort enkäten heter Oskar och Linnea och vi gör under våren och sommaren 2013 vårt examensprojekt på Teknisk Design på Chalmers i Göteborg. Tillsammans med företaget Ascom Wireless Solutions utvecklar vi en produkt speciellt baserad på sköterskors och patienters kommunikationsbehov på morgondagens sjukhus. Denna enkät är ett komplement till de intervjuer och skuggningar av sjuksköterskor vi gjort på olika vårdavdelningar runt om i Sverige.

För att göra vår produkt så bra som möjligt skulle vi gärna vilja veta mera om dina upplevelser kring kommunikationen med sköterskor under din/dina vistelser på vårdavdelningar. Fyll i enkäten så bra du kan, och är det någon fråga du inte vill svara på så kan du lämna fältet tomt.

Hur gammal är du?
- ○ yngre än 20 år
- ○ 20 - 29 år
- ○ 30 - 39 år
- ○ 40 - 49 år
- ○ 50 - 59 år
- ○ 60 - 69 år
- ○ 70 - 79 år
- ○ 80 år eller äldre

Vid hur många separata tillfällen har du legat på en vårdavdelning under det senaste året?

Hur upplevde du kommunikationen med sköterskan/sköterskorna under din vistelse?
Vid olika separata vistelser, berätta gärna om flera.

Vilken typ av information ville du ha från sköterskorna under vistelsen?

Vilken typ av information upplevde du att sköterskorna ville ge dig?

Om du hade fått tillgång till vilken information som helst när som helst under din vistelse, vad hade du velat ha då?

I samtal om annat än ditt sjukdomstillstånd, vad ville du helst prata med sköterskorna om?

Är det något annat som skulle fått dig att känna dig gladare och tryggare under vistelsen? Vad?

Din mailadress: (frivilligt)
Fyll i din mailadress om du vill ha information om en uppföljningsenkät senare under våren. Du kan även hitta resultatet av vårt designprojekt på www.teknuskdesign.se/master/examensprojekt när det publicerats om ca. ett år.

Submit
Never submit passwords through Google Forms.

Appendix 4: Summary field study

(I)   Interviews

(O)   Observations

(SN)   Survey Nurse

(SP)   Survey Patient

Context

- Shifts: Day, evening and night. Similar shift times at all wards (I)

- Working in pairs, 1-9 patients/nurse, nursing pair or team differs from ward to ward (I)

- A common problem: Too few phones and pagers due to organizational issues (I)

Non-communication

Carrying and dropping device

- In/on pocket of shirt/pant. Differs from nurse to nurse. Inside pocket of shirt, in clip with device inside or outside shirt pocket, or in clip outside pocket of pants. (I)

- One nurse said that the pagers tend to be dropped, so a security strap from Ascom was used. (I)

- Cleaning: Done only occasionally when dirty, no regular cleaning of device (I)

Alarm to nurse communication

- If a sensor falls of, the machine sends an alarm. (I)

- The technical alarms are not visible on the wall/sealing displays, but they are connected the paging system and the displays/speakers in the reception. (O)

- A patient created alarms all the time, the nurse and doctor therfore decided to increase the pulse required for an alarm. (O)

- Consequences if nurses don't receive alarms and calls; delays for the patients and healthcare, negative atmosphere within the personnel group. (I)

- There are screens in the corridors/modules/patient rooms continuously showing overviews of medical values for several patients. (I)

- At one ward they can call phone number 90 to alert and call for a central emergency team of the hospital. (I)

- There are three ways of creating a patient alarm (meaning manual alarm or not from machines): (I)

    o Red button: Nurse call, meaning "I need help" from patient. This button is (often) situated next to (or in) the patient's bed.

    o Yellow button: Nurse assistance, meaning "I need help" from nurse. This button is also situated by the bed of the patient.

    o Green + Red button on wall in patient room: Big alarm, meaning "Emergency!" from nurse. The nurse shows presence in the room by pressing the green button, and then calls for emergency help with the red button.

- There is a detected problem with the Emergency alarm, causing the nurses not using the green presence button as intended. The red button next to the green one on the wall has the same meaning as the (red) Nurse Call button. This means that if the nurses use the green Presence button in the way as intended by the alarm system (meaning depressing it whenever entering the patient room and pressing it again when exiting to release it), and a patient uses the nurse call while that button is depressed, the Emergency alarm goes off and all the staff run for it. The same situation emerges if the nurse depresses the green Presence button when entering a room, but forgets to press it again when exiting. If a patient uses the nurse call button in that room while the green button is depressed, the emergency alarm goes off. (I)

- There is a risk for alarm fatigue. A nurse said that "There is a bird-like sound, I don't really know what it means". The other nurse replies that "It is always a false alarm". (I)

- The nurses are exposed to beeping nurse call sounds frequently (how frequently?). Only if it is their own patients that are calling, and if they are not doing something they cannot walk away from, the alarm trigger any reaction (apart from looking at screens showing room/bed number calling – if availa-

ble for nurse). (O)

- When an urgent alarm is triggered (in this case, probably a medical alarm from telemetry) nurses move about in the corridor within seconds to find the reason for the alarm. However, in this case it was false and one nurse instantly tells the others it's nothing. (O)

- When another urgent alarm is triggered (from the telemetry), a bell-like dong-sound is heard. When one goes off, two nurses come running in the corridor towards the room where the bed of the patient who has the telemetry is. Then they find the patient in the dayroom, and ask the patient if they feels OK. One nurse tells the patient that there are some disruptions on the technology. Then a nurse who ran on the alarm asks the shadowed nurse about something on the telemetry monitor, and the shadowed nurse says that "No, it is just disruptions".

Alarm levels

- One interviewee requested different levels on Nurse Call, taking the example Service call and Pain/Medical call. (I)

- The levels of the medical alarms can be adjusted and are adjusted to the circumstances for each individual patient. (I)

- Technical/machine alarms have three different levels. (I)

- At one ward, the loudest alarm is the one indicating that the door to the medication room has been open too long (approx. 5 minutes) and it is silenced by closing the door. It makes a high-pitched, persistent beep until it is silenced. (O)

Reaction on alarms

- At one ward, all alarms go to the nurse station ("disken"). There are always staff there (nurses), who will acknowledge the alarm and go to the patient immediately. (I)

- One interviewee says that "Some days, the phone at the reception desk rings constantly!", and refers to when the secretary is in a meeting, etc. (I)

- When one nurse sits at a computer writing a document preparing for the handover, a nurse call is received to the monitors. The nurse hopes someone else will respond to the call and says that "of course that does not have lower priority than this, but I just want to finish this." However, after 20 seconds or so since the alarm started, the nurse stands up and goes to the patient calling

- While the nurse gives the antibiotics to the patient, an alarm beeps. Since we are stuck here we can't go there... the nurse says. (O)

- "It's so nice to come home, it's completely silent" says one nurse according to the alarms.

- Silent pagers were asked for at one ward, since using it would reduce the amount of noise, and the concerned nurse would just get the notification

through discrete vibration instead. (I)

- During one visit in the medicine room: The door starts to beep, since it's open. The c-nurse pulls down the handle and the alarm stops. (O)

- The door starts to beep again, which forces the c-nurse to pull down the handle once more. (O)

- The door beeps, first slow than a bit faster until the c-nurse pulls down the handle. (O)

- The door alarm starts over; the c-nurse pulls down the handle, walks out and closes the door. (O)

Nurse to nurse communication

- "All our communication is mostly that we are running around looking for each other" (I)

- The nurse asks the resource if she could take a blood sample from a patient, and gives her a referral paper. (O)

- When entering the ward room, the nurse has a note on her desk, "probably from the coordinator nurse." (O)

- During lunch the nurse is asked to go to the reception since there has been some confusion regarding one of the notes in the notebook for the resource. The misunderstanding is explained by that someone had made another note beside the nurse's first one. (O)

- The nurse is going to change PKV at one patient in room 6 and therforee moves the wagon with needles there. At the same time the resource nurse are going to take a blood sample from the other patient in the same room. - Are you doing all my tasks today? (since she thinks the wagon stands there because the nurse is going to take the blood sample on "her" patient) (O)

- One ward had an Ascom telemetry device, which had bad battery and was perceived as unreliable. (I)

- During the reconciliation between nurses and physicians they mainly talk about the current situation, if the patient should be involved in the round, and what the future looks like (medicine, operation, discharge etc) (O)

- In the notebook at the reception where everyone can write down tasks that the resource nurse should do, the nurse writes "give blood to 5:2". (O)

- "It is sometimes hard to know when it's OK to disturb someone, and when you should write a note." (I)

- "It is a lot of running in this job. We are running down to the X-ray department a lot." (I)

- Nurses often have to check themselves for lab results, whether they are done or not. A nurse goes to the office and checks for lab results in a pile of papers. Discovers they are not there yet. (O)

- A secretary (?) has left a post-it note on the computer screen in the office. The nurse picks it up and reads a name and phone number to a family member of one patient. 5 minutes later a colleague enters the room and asks the nurse to call the family member. (O)

- Sometimes a nurse receives information from a colleague about a patient, and writes some words down to remember it. In some cases, no note is taken at all. (O)

- An analogue medical record copy can be lost in the hospital logistics, and then the nurse has to call the origin ward and ask about where it is. (O)

- I'm now going to check my terrible e-mail, it is stressful. (O)

- "I think that the data-society shouldn't cause that much paper, but it feels like I use more paper than ever." (O

- The c-nurse walks to ward 4, a ward they cooperate with, she brings the folder with the schedules. She's having a meeting with a coordinate nurse at ward 4, who has a similar folder. (O)

- Have they changed the patron in the printer now? The c-nurse says to a nurse standing by the printer behind the desk. (O)

- Another nurse walks in and she and the c-nurse discuss a problem regarding lack of adrenaline. The personnel during the week-end didn't know where they could find refill. "We have talked about that, don't they listen..?" (O)

- At 14:00 the c-nurse should have shown the HLR stock for some other nurses, but they have to perform some tasks first. "Come back here when you are done!" the c-nurse says. (The nurses are back at 14:20 and they decide to wait until after the meeting at 14:30) (O)

- Before the meeting is about to start, the c-nurse from ward 4 tells that one nurse they assumed should call in sick had not, and one more nurse were should not be absent. The c-nurse should return in the matter though. (O)

- Sometimes, immediate action is needed and performed by the nurses. Example: (O)

   o 19.31 A phone rings, another nurse hands the phone over to a nurse. The nurse receives information about that a patient should not eat any food (because of upcoming x-ray or similar), but drink contrasting fluid instead.

   o 19.33 The nurse hangs up and walks straight to this patient. The nurse asks two colleagues on the way to the patient's room whether the patient has eaten yet, and they reply a No. The nurse tells the patient that they cannot eat but feel free to have some tea if the patient would like to. The nurse leaves the room and takes the non-eaten sandwich with him/her from the patient's room.

   o 19.38 The nurse is back in the office and asks two other nurses that are sitting down to get contrasting fluid.

- Nurses often ask a more experienced colleague about medical as well as practical topics. Example: A nurse from another department at the ward asks the nurse shadowed about interpreting a received lab result which is special. (O)

- If one nurse does not have the time to perform a task, sometimes a colleague does it instead. Example: A nurse hears from inside a room that a bed is being punched though the corridor. Says "Oh, now they are proba-

bly taking the patient down to the x-ray", something that the nurse got on the "mental to-do-list" but had not had the time to do yet. (O)

- Nurses spread information orally by retelling the same information to different people at different occasions throughout the day. Example: A nurse says that "this patient is in great pain, we can barely touch the patient" during the round with physicians. The nurse has already told other nurses this phrase at least 2 times earlier during the shift. (O)

- At the morning information meeting for all staff in one ward, a nurse tells everyone that "this patient has multi-resistant bacteria, which didn't say on the field 'Warning' in the medical record!" (O)

- Trygg hemgång: ('Safe journey home') It is the most resent version of Vård-planering ('Care planning'). For Trygg Hemgång, the planning of the care needs after discharge is done in the patient's home instead of at the ward. Therforee, nurses from the Home Care ('Hemvården / Hemtjänsten) and City Council ('Kommunen') call the nurses at the ward a lot more than earlier nowadays because they all need information about the patient, and the ward nurse will not be present at the meeting (as they were earlier when being held at the ward). (O)

- Round: A nurse brings the whole medication trolley with computer on into the office were the round is to be held with two physicians. Both the physicians look at one computer each in the office during the round. (O)

- Round: When telling the physicians about patients during the round in the office, the nurse reeds from their handwritten note, reads the medical record and adds information taken from the back of her head (not written down at all). (O)

- The nurses have (if having time for it) shorter reconciliations throughout the day. They then communicate to each other what has been done, how (how wounds have been treated, etc.) and info from other functions that needs to be shared with the colleagues. (O)

- Sometimes the source of information is unclear, which can lead to misinterpretations between the nurses. A rather funny example: During a short reconciliation within the nursing team, it is sorted out that one patient who the nurse assistants thought was to be discharged from the ward today will not be discharged at all this day. It is not certain when it is time for the patient to go home, but it will certainly not be today. But the patient has told the assistant nurses that it is going home, and they have picked up the patient's private clothes and put them on the patient. When discovered it is not correct, the nurses giggle a little and one says that "well, it is probably comfortable for the patient to wear private clothes today, so the patient can keep them on today." (O)

- Nurses write digital messages (possibly within the medical record system) to the healthcare centres ('vårdcentralerna') about practical things related to the patients care, such as how a wound should be treated. (O)

- Lab results are not always DONE or NOT DONE, the complexity in collecting them is more complicated. The nurse shadowed explains that "The lab

personel don't have access to the patient, they just have the sample or test, so they cannot always see how fast we want to know in which direction the lab result might be. So for instance, in the case of bacterias, they often wait until they have a substantial amount before seeing the test as finalised and tell us at the ward. However, it might me critical to us to know fast whether there are bacteria or not in that specific sample, so that is a reason we sometimes cannot wait for the final result, and call them instead. (O)

• "Sometimes it's a huge problem with information transfers in several leads [..] It's a risk that some information disappears between each step." (SN)

• We don't talk that much to each other, but instead we forward things to the manager (who will talk to the person concerned. (SN)

• "It's difficult/impossible to just leave a patient in the middle of a task" (SN)

• "The stressful environment makes it hard for the personnel to communicate with each other properly, since everything has to be done rapidly." (SN)

• When one patient has leaved the room, the nurses and physicians talks about which tests that should be prescribed, and a printed list of those is written out and given to the resource nurse (who will perform the tests.) (O)

        - Physician: Did I ask for SPN on a patient? (O)

        - Nurse: Yes, i just wrote it down

        - Physician: Good, I couldn't remember if I said it.

• "To get help quickly I usually shout, or press the closest alarm button" (SN)

Phones

• The amount of phones at the ward differs among hospitals, but as a standard each nursing pair/team have a shared phone (phone number) (I)

• Phones are mainly used to call and receive calls from staff and to receive LAB results (if values are critical, otherwise the result only comes via computer/analogue) (I)

• Phones are also used by nurses for contact with relatives to the patients, both for incoming and outgoing calls. One nurse received calls from relatives approx. 3 times a day. The call was often put through by a receptionist so that they could ask the nurse weather they could take the call or not. (O)

• The telephone rings, it's another ward who asks about the current covering. The nurse says the ward is filled and has overcrowding. "We have a prio 3

patient though." (regarding cardiac monitor) (O)

- Another nurse asks the nurse: - do you have a telephone so I can call the medicine physician? (O)

- Different nurses receive different amount of calls, depending on ward and position. (I)

- If secretary calls and nurse can't pick up, the nurse will cancel the call and the secretary will try to call back again later. (I)

- Sometimes a call is not answered in the reception of the ward. (O)

- "We hate telephones." (I)

- At one ward they really wanted to put less time on phoning and respond calls, and also finding telephone numbers to other hospitals and departments. (I)

- "Nurses rarely answer their phones since we are so busy" (SN)

- In the corridor the nurse gets a question about taking a phone call regarding a change in which patient that should be monitored. She talks with another nurse about their situation. (O)

- "It's hard to know where and when you should call." (SN)

- The phone rings, regarding personnel resources. The nurse fits in to ask if they know when the manager arrived to ward 5. As a consequence of the phone-conversation the c-nurse makes a change in the schedule inside the folder. (O)

- The telephone rings, the c-nurse responds continuously as she is searching in the folder. During the conversation she makes some notes in a notebook in the room. (O)

- The c-nurse opens a phone list at the computer, the telephone rings. The c-nurse takes some notes. Afterwards she opens the phone list and makes a call. (O)

- The c-nurse has a phone conference with the c-nurse at ward 4 and another c-nurse regarding personnel covering. (O)

- C-nurse tries to call someone who is busy/can't pick up. (O)

- The c-nurse makes another call; the responder wants to call back later instead. (O)

- The phone calls silently in the c-nurse's pocket; she answers and discusses a future meeting. (O)

- The c-nurse discovers that she had got an answer on her previous text message (about two hours earlier.) She tries to call but doesn't get an answer. (O)

- The phone calls again, about another meeting, they decide to have it tomor-

row at 11:00. The c-nurse makes a note about it in a "to-do- tomorrow" list. (O)

- A nurse is just about to eat lunch when the phone rings. The nurse takes it although it is lunchtimes. The nurse says: "It was the city council ('kommunen'). It is always good to take the call when it's them because they are a bit hard to get hold of once you have to call them back." (O)

Finding colleagues

- A lot of nurses say it's hard to find other nurses, and this could sometimes take a lot of time. Still most of them wouldn't like to know where everyone was through a digital product. (I)

- Another nurse is trying to reach the medicine physician about checking a patient's pacemaker so the patient can be discharged. She does not reach the physician but soon discoverers that he already is with the patient. (O)

- "To find someone, I'm walking around and check the presence lights" (SN)

- A nurse says: (O)

  - I need to talk to Lasse. (physician)

  She asks another nurse:

  - Where is Lasse?

  - You have to call him in that case..

  Another physician passes by and calls out his number. (O)

- Nurses look for eachother at the ward if they need assistance when performing a task. (O)

- "We always look for each other, if we can't find the nurse we are looking for we ask someone else, or ask for help later" (I)

- One nurse expresses that "it would be great to be able to know where everyone is". (O)

- A physician is searching (in computer) for a physiotherapist. One nurse says "she is called Liselotte, with an ordinary last name" (O)

- "It would be great to be able to know where people are." – Expression from a nurse (O)

- Two interviewees said that if they or someone had a hard time generating an alarm, they were yelling for help instead. (I)

- At some wards each nurse team have one own portable computer and one stationary. (I)

- The secretary relieves some administration work for nurses, like taxi-booking etc. (I)

- The nurse has a delegating function towards the assistant nurse, but it is also collaboration between them. If they can't find each other within the nursing team, they can ask a nurse / assistant nurse from another team for help instead. (I)

- Sometimes a physician says another thing to the patient than they have said to the nurse earlier (for instance changing drip rate after talking to the patient) Sometimes the physician forgets to communicate such changes to nurses which creates a problem. (I)

- At some wards all calls are received through the reception. (I)

- One ward did not have phones for each nursing pair/team which was seen as a difficulty. (I)

- One nurse takes the medication trolley out to the corridor of the ward where easily found and distributes the medicine from there. (O)

- Another nurse asks "if you could move the wagons here?" This took about 10 seconds and the nurse is then continuing towards the reception. (O)

- The nurse is looking for the resource, she hasn't given blood yet (which the nurse asked her about earlier) (O)

- A nurse walks into the medicine room: -"could you help me with one thing?" while talking in the phone? The c-nurse puts in the card once more. (O)

- "To find colleagues I usually look at the presence sign outside the patient rooms their have responsibility for. (SN)

- "We walk around until we find the one we are looking for, we don't have any GPSs yet.." (SN)

- "I walk around, trying to find my colleagues, sometimes I try to call" (SN)

- "Sometimes it's hard to find colleagues" (SN)

- "I often search for staff in the medicine room and in patient rooms" (SN)

- "To find colleagues I usually go around looking, and asking other nurses" (SN)

Whiteboards

- Outside the reception at one ward there is a whiteboard with today's personnel. C-nurse asks me to write down the names for the evening and night shift since she can't reach the upper fields. Also temporary absence (as an assessment interview) is marked at the whiteboard. (O)

- At one ward-room they have a whiteboard with all the patients and their current situation. They have a colour system for the patient situation: (O)

    o   Yellow: something is happening

    o   Red: new patient

    o   Blue: waiting

    o   Green: finish

- At one ward they had developed color marks on a whiteboard to communicate the patient situation. (I)

    o   Red = Fast action

    o   Green = Everything under control at the moment

    o   Yellow = Ready to be discharged

    o   Blue = Have been at the ward for long time

- Most wards have a whiteboard in the reception aimed for communication but they are used differently at different wards. (I)

- At one ward each expedition had an whiteboard, with information about patients and their individual planning such as surgery, x-rays etc. (I)

- It is perceived as important to maintain order and continuously update the whiteboard as soon as something is happening. (I)

- If a patient is discharged, this has to be communicated to the ward in some way, otherwise only one or a few of the staff is aware of this change. (I)

- At one ward the whiteboard was used to inform about today's teams and their phone number. (I)

- The weekly planning was made in a folder, and manually transferred to the whiteboard each day. This was requested to be done digitally. (I)

Information to staff

- Patient planning is made together at the intranet. (O)

- Information told to everyone at the morning meeting: (O)

    o Extra hand hygiene at room 1. A nurse adds that this also regards room number 6.

    o They are terrified that we don't use the scanner when giving blood to patients (where are the scanner?)

- Reading a note about a meeting on the door outside the personnel room: - We are having HLR then, how are they thinking? (O)

- They put a X beside the patient if they should be included in the round (which take place in the ward-room) and a XR if they are included in the round but cannot be moved to the ward room. (O)

- At the reception there is a folder, with upcoming event everyone at the ward should know about. (O)

- The nurse changes the prioritization (cardiac monitor) on one patient ("it was him, right?") (O)

- The c-nurse formulates an announcement on the intranet, about a new product they maybe should start to use. She asks a nurse to check the price for the product "before I recommend it on the intranet." Though, she continues to write the announcement. (O)

- The nurse who was checking the price for the new product tells that the cost will be the double compared to the older ones. The manager had at this time already approved them though, since they seem to be better in several ways. (O)

- Two nurses are writing an incident report about a patient who was lying without oxygen a whole night, because the tube wasn't turned on. (O)

- (Sits down) C-nurse completes and sends the announcement on the intranet, regarding the new products.

- "Now I have to decide the nurse teams for next week" (taking out a paper from the folder) (O)

    o Some people can see it automatically (the groups)

    o I do not... it requires some practice (Makes circles around a "1", "2", "3" and "resource" to decide groups)

- In the folder, they use to make orange dots in front of the responsible nurse, especially during the week ends. They choose the calm and experienced nurses. (O)

- Regarding the teams; you want to have continuity, which is good for the patients since they will get not know the personnel better. (O)

- C-nurse makes a call to fill a gap in the night shift, and gets a positive respond on the first call. "Sometimes it takes the whole day to find a nurse who can work." (O)

- One nurse coordinator would like to have time for shorter reconciliations within the nursing team during the day. (I)

- One nurse coordinator would like to have a "coordinator day" where she could inform about happenings and changes at the ward. (I)

- To have a morning meeting is perceived as a practical and effective information channel, everyone who works will get the same information at the same time. The information concerns patient's health and special events, managers planning for the day and other information regarding the staff. (I)

- At one ward they could play a special signal in the speakers which meant that everyone should meet in the reception to receive important information. Less important information was spread either orally during the day or through intranet / email. (I)

- Email is mostly used for personal contact, while the intranet consists of information regarding the ward or the hospital. The nurses should check their email at least once a week, but those who usually don't receive email that often will check it more rarely. (I)

- Although a nurse is working with care (non-administrative job) a specific day, the nurse still checks the e-mail and invoices anyway when having some spare time in-between other care-related tasks. (O)

- At one ward, they have a daily morning meeting with all staff working at the day shift. Practical information is given orally and the ward's intranet is scanned and it's new content discussed within the staff group for about 30 minutes. (O)

Finding stuff

- Someone enters the reception and wants to meet a special nurse; C-nurse walks out to the whiteboard to check which team they belongs to. At the same time her telephone calls, she answers while she is showing the person who asked for help her way to the nurse. (O)

- The other c-nurse asks: - Do you know where the document for overcrowding is? (O)

- Just when the c-nurse is about to go, the other c-nurse asks: - Do you remember when the SY meeting was? – Nope.. (O)

- C-nurse starts to walk again. – And you didn't know where the document for overcrowding was? – Nope. (O)

- "Do you have any keys to our medicine room (at ward 5)? Maybe we should leave one to you, in case of we lock our keys inside?" "Maybe we should have one of your keys and vice versa?" (O)

- Someone has moved the c-nurses' folder and when she finds it she asks: - is this mine? (Reads it and understands it is) (O)

- The c-nurse finds another folder, and calls a number printed on the front. She asks about the fax forms. "Aha, there they are.." (at the intranet and not in the computer system) (O)

- Finally she finds the form at the intranet: - what shall I write here then? (in phone) (O)

- Another nurse enters the room and looks for someone. (O)

- Another nurse comes in telling the c-nurse that if someone is looking for her, she's buying lunch. (O)

- The nurse is looking for a scanner used for scanning the blood bag, before given to patient. She founds it in the reception. (O)

- The phone rings; a patient have got an MRI at 11:00. The nurse therfore has to find a questionnaire and asks a colleague about where it could be: - "probably in the computer?" The nurse finds the document in a folder at the reception though. While she pastes a ID label on it she asks another nurse if she later could weigh the patients. Then she goes to the patient room and leaves the questionnaire on the bedside table. (O)

Handover

- - Example on one handover: (O)

    - Patient name and number

    - Why is she here?

    - Current history?

    - Upcoming events?

    - How does the patient feel right now?

- In the beginning of a shift, nurses have an oral handover with nurses from the previous shift. The nurses that start their shift take hand-written notes on papers during the oral handover. (O)

- Sometimes, the nurses start the shift by reading the medical records, checking test/lab results, taking own notes on paper, (which all takes about an hour), and then have a complementary oral handover. When reading medical records, the nurses can be in pairs and discuss what they read with each other. The questions that arise is then posted at the oral handover. (O)

- Info that is asked for by the nurses starting their shift who have just read the medical records is if patient's need work assistance in practical things, what the nurse has done while the new nurses rea the records (which is then of course not in the records yet) and patients' attitudes. (O)

- If a nurse has worked at a recent shift, they already knows a bit about the patients which makes the handover shorter than if the patients are all new to the nurse. (O)

- A nurse is told orally by another nurse that one/some patients shall have their medicine a bit later than it says in the medical record since the previous dosage was delivered a bit late. (14.00 instead of 12.00) (O)

- According to a nurse, they often receive "a lot of information in the format of a pile" (I) when having the handover.

- One ward had oral handover, but they used a standard paper with information about the patient as a support. This paper was updated (digitally) after each shift, and the old printed version was destroyed. (I)

- During the handover the nurse becomes aware of tasks that have been forgotten during the day and asks if the nurse for the next shift can do those tasks. (O)

- Evening to night handover; at one ward the nurses read through the medical record when they arrive, and afterwards they have an oral handover. (I)

- Most things are mentioned in the medical record, but some things are not. For instance "the patient did like this and that". (I)

- Practical details about how the patient is like to treat and how the nurses can do it in a practical way are exchanged between nurses only orally during handover. Also patients' characteristics and attitudes are such information that is only discussed orally. (O) (I)

- At one handover, specific attitudes of relatives to a patient is given only orally: "The relatives are very intense" ('anhöriga är väldigt "på"') (nurse) (O)

- Some information is said to disappear if they only have a written handover. When reading the journal some doubts or questions often appear which are easier to get answers to when having an oral handover. (I)

- Sometimes the nurse remembers things during handover which are not written in medical records or anywhere else for the next shift to read. Example: "Oh, that patient has a catheter, it does not say in the record". (nurse)

- The length of the handover is sometimes a problem, and perceived as too time consuming compared to what is considered to be necessary information. (I)

- At some wards the handover is said to be oral, but the nurses have the responsibility for having all the information, which implies that they do read the medical record as well since "oral is oral" (implying that some things will get lost). (I)

- There is always an (personal) interpretation in information you send / receive. This applies for bot emails, medical records and also oral communication. (I)

- Chinese whisper ("viskleken") is a problem, because everything is interpretations and misunderstandings can easily be propagated. (I)

- Consequences of a bad handover could as a worst case imply risks for patient safety (I)

- At one ward, they use so-called letters as assistance during handover. The letter is produced by the nurse at the first shift who is writing down the patient's names and approx. 2 rows per patient of information that is the most crucial and important one to handover to the next shift's nurse. (I)

- "Handover takes 5-20 minutes" (SN)

- "We are trying to report according to SBAR" (SN)

- "During the handover we focus on things that happened recently, or things that are about to happen soon." (SN)

- "It's a problem when you refer to the medical record but the one receiving the information don't have the time to read it, thus some things may be missed." (SN)

Writing Medical records

- At one ward they had ID cards as identification when using some computer, but also to get into for instance the medicine room. When they have to rapidly move from the computer, information sometimes disappear since they have to drag out the card from the computer fast. (O)

- The vast majority of the information regarding the patients is written in the medical record, but in certain sensitive cases the patient could be asked if some information shouldn't be put in the record. (I)

- Everything that is written in the medical record could be read by the patient (and possibly also relatives and kin if the patient allows it). (I)

- Non-medical information does not belong in the medical records. (I)

- At some wards there are computers outside every patient room, aimed for medical records writing. (I)

- It is perceived as much an increasing amount of time is put on administration and documentation nowadays, compared to some years ago. This is, according to one nurse, because the demands for documentation have increased. (I)

- Some wards have a lot of portable computers, but they are seen as impractical to bring to patient beds for writing medical record, even though some nurses were using it. (I)

- Information that has to be written in the medical record: (I)

     o   Warnings/observations

     o   General allergies

     o   Blood contamination

     o   MRSA culturing (if patient has been treated at hospital outside Sweden)

     o   Work/profession

     o   Use of tobacco (should already be there before arrival at the ward)

- SBAR is a working method for information writing in medical records and handovers. (For details, see interview.) (I)

     o   Situation

     o   Background

     o   Actual (current) condition

     o   Recommendations

Reading Medical records

- The structure is important, especially when the medical records contain a lot of info. (I)

- If patient information exists at the specific ward, a nurse from this ward will receive that information as directly when they is searching for a the patient in medical records system. Otherwise a broader search is required. (I)

- In VGR ('Västra Götalandsregionen'), almost all hospitals have separate systems, and if a nurse/physician needs patient information from another hospital they have to contact the hospital and they will have to fax / email the medical records. (I)

- At one ward at one occasion, three patients have an incorrect time for their medicine intake in the medical record. This is possibly connected to information received by the nurse from colleagues in the beginning of the shift saying that the previous medicine delivery was delayed and therforee this dosage shall be later too. (O)

- Sometimes, an incorrect entry in the medical record can spread to a lot of different people before it is corrected, and the nurses then have to keep track of the info and inform colleagues that it is incorrect. Example: A nurse discovers that it says consequently "left leg" in one patient's medical record, although the nurse thinks it is supposed to be the right leg that is injured. During the round at the office, a physician reads "left leg", and the nurse points out that it is likely the right leg that it is supposed to say. Right then, the nurse sees the patient concerned in the corridor in its bed, being transported by another nurse. The quickly goes out in the corridor, looks at the patient and asks the nurse pushing the bed whether it is the right or left leg that is injured. The answer is the right leg, which the physicians then also know. However, at the handover from this shift the new nurses that are taking over read "left leg" in the medical record, and the nurse that first read about the incorrection then have to point out to the new nurses orally (from the back of the head) that it is supposed to be the right leg. (O)

- If a patient is included in a scientific study, this is displayed under a special tab in the medical record. The nurses see it when reading the record. (O)

Identification of device

- The most common way for nurses to identify their phone is to look at the display and by reading the telephone number understanding who it belongs to. (I)

- Some nurses have taped a paper with a name or color on the backside - to make identification easier, but this perceived as being a little bit unpractical and not hygienic. (I)

- They would like to have an opportunity to select from different colors or something else on the outside of the phone to easier identify the device.

Nurse to self communication

- "It's much easier to remember things now compared to when I was a new nurse." (I)

- Nurses ask each other a lot of patient-related questions throughout the day but do not always take a note of the answers. Notes are mainly taken in conjunction to handover or more formal reconciliation. (O)

- Nurses keep a lot of information in the back or their head. (O)

    o   Example 1: At one occasion, a nurse suddenly remembers they should get a thing from another department. The nurse takes out a paper to fill in.

    o   Example 2: A nurse tells another nurse that a patient should go to an x-ray at a specific time. The nurse replies "am I supposed to remember that?"

Interruptions

- Example of interruptions: While a nurse is picking up medicine from the medication trolley in the office, a nurse call beep interrupts. The nurse checks a sign instantly to make sure it is not the one of the nurse's patients calling. After 5 minutes two other nurses enter the room and interrupt the nurse by asking for a medicine list for a patient. The nurse says that the physician should have transferred/updated the list, but they instantly calls the physician on duty ('jourläkaren') to ask for the list. Then the nurse goes to the reception and faxes something (the list?) to the physician just con-tacted. When being back at the medication trolley, the other nurse discusses with the nurse if they are out of a specific medicine. Then, a third nurse walks by and asks for exactly that medicine. They discuss this, all three nurses. Then the nurse proceeds with the medicine sorting. (O)

- Nurses are interrupted in their work all the time, and therforee they have to learn how to prioritize different tasks. Also they have to remember what they did before they were interrupted. This prioritizing is especially hard for nurses with little work experience. (I)

- Since they (nurses) always are doing something, they are interrupted each time somebody wants them anything. (I)

- "I almost always get interrupted in my work." (SN)

- "I'm always interrupted!" (SN)

- "We are constantly interrupted and we don't manage to complete task A before we have to start task B" (SN)

- "I'm often interrupted, of other nurses, physicians, the telephone etc. I have to write down thing I have to do, else I forget." (SN)

- Nurse walks with a physician from another ward to a patient. The nurse is interrupted by another nurse who looks for the paper needed when measuring blood level. - I got it here! Walks back through the corridor and leaves it where it should be. (O)

- A nurse enters the reception and asks: "do you write in the medical report if a patient should be autopsied?" (O)

- The nurse is interrupted by a physician who asks about an order of new blood. (O)

- A nurse walks in the room, they have a short dialogue. (O)

- A nurse is entering the reception. "Did you get any order?" (Regarding a previous conversation) (O)

- C-nurse walks to the medicine room to order some medicine. Just when she has started a nurse comes by and checks what the personnel covering looks like. (O)

- The c-nurse is interrupted by a colleague who fixes with the printer. She makes some small talk with her, at the same time as the c-nurse continues with her work at the desk. (O)

- The c-nurse is interrupted by the receptionist, who asks something about the ID number, and when a meeting is. The c-nurse is uncertain about this, so she asks the receptionist to check it. (O)

- Two nurses are going to retrieve a patient, one nurse deviates since she discovers another patient who need help. The other nurse reminds herself that the patient who should be retrieved needs to have new drip. She goes to the medicine room, where the second nurse finds her a bit later: "where did you go?" They change drip, and then decides to tell the physicians that the patient it is more sufficient to have the round at the patient room. The physicians and nurses decide to have the round at the patient room. (O)

- What did we say about this..? (takes one of the potential new products lying on her desk, which was put there earlier) (O)

- There is a lot of things going on right now.. (stands up again) (O)

- Due to interruptions some information could get lost which for instance could result in that a patient needs to ask for analgesics several times or that one patient misses its X-ray time and needs to wait for another opening. (I)

Memory

- I would like to have a reminder function for doing things like give insulin, take blood sample etc. Discrete reminders and easy to use." (I)

- "We have to remember things in our heads"

- "If it's just about what the patient want in his or hers coffee I just put it in my mind until I've time to bring it to the patient." (SN)

- "I try to make a mental note to remember what I did before I was interrupted. (SN)

- "The hardest thing when I was new was to remember all the small things" (SN)

- One patient asks for an enrolment certificate, since he eventually will have to appeal against a parking fine. The physician says "no problem, the nurse says "just remind the personnel when you are discharged, it might not be we who are working then" (O)

- "Hi Yvonne! It was something that I was going to ask you.." (O)

Notes to self

- "Coordinator nurse looks at her to-do-list, by scroll through a pile of paper. (O)

- Reading a to-do-list in a notebook and says: "a lot of old stuff that could be crossed." (O)

- The telephone rings, someone is calling in sick for tomorrow. The c-nurse makes no note about it, but says that she will call someone later. (O)

- "I need a check-list for the emergency cart", c-nurse writes in a small note book.

- I have to call a person before I forget it, or I could send a text message, but that's takes such time, I'm so slow… (Writing a text message anyway.) (O)

- Regarding the intranet: - What have happened here, they change a lot of things so you can't find them.. ah, it was me who did it wrong. (O)

- "I was doing something here..?" (O)

- "What did I do before..? the checklist.." (O)

- "Oh right, I had to talk to her.." (O)

- The nurse is looking through all the PKVs and which one that should be exchanged. She takes notes in a notebook. (O)

- The c-nurse walks down to the meeting, but realizes that she might need something to takes not upon, so she walks back to the reception and collects a notebook. (O)

- C-nurse, "Oh, it was a new patient that should come here, from KAVA." Walks to the receptionist and says this, but she already knew. (O)

- Another administration worker (how recently was using the printer) comes back; "I always forget my glasses" and pick them up by the printer. (O)

- The manager suddenly appears at the reception (she was gone during the morning.) The c-nurse talks with her about some stuff, using her notebook to remember something she wanted to ask. (O)

- Oh, patient 6:2 needs drip, the nurse suddenly exclaims (O)

- The c-nurse walks to the reception, but realises she forgot her pen at the emergency cart and goes there to pick it up. (O)

- "I'm afraid that I will forget something when we have this much to do" (SN)

- Nurses take notes from medical records on paper(s) to carry around with them during the day. (O)

- Nurses often write notes which are saved until the next day, if the patient stays at the same ward, otherwise she destroys them. Every nurse has their own system, and the notes are only for personal use. (I)

- When taking notes from the medical record, it's mostly for their own leaning purposes; the nurse does not look at their own notes often. (I)

- One nurse said that she usually writes notes on her hand to remember the name / dosage of a medicine. (I)

- Nurses carry around a lot of pens; "one ink, one pencil, one red ink ('a must have') and one extra for physicians who forgets" (I)

- One nurse said that her memory is worse now than when she was new. She used her pen and notebooks, post-it's on her clothes and marker on her arm to make self-reminders. (I)

- "To just write information and reminders down doesn't really help when it's something you should do." (at a aspecific time or situation) (I)

- "I use to have a prioritization list in my head, if I forget something I try to follow the list, otherwise I continue with the next task and I will remember the first thing eventually. If not, I think about a former sequence to remember.." (SN)

- "I write things down on paper, else I remember in my head.." (SN)

- "I usually write down the most important stuff."

- "We have a "status-function" in out data system that makes it possible to write a short text about each patient and upcoming events. This gives us a quick overview." (SN)

- "I have a compilation of all the patients on a paper, where all the most important information and tasks regarding the patients are written." (SN)

- "I write small notes about everything that has to be done." (SN)

- "I'm writing lists, checking lists, re-prioritizing and using task lists in medical records" (SN)

- "I'm writing things down in my notebook." (SN)

- "I'm using my report document to remember what I have to do with the patients; otherwise I'm trying to just remember it." (SN)

- "I'm using a overview document and a manual to-do list to remember things" (SN)

- "I'm writing a list on everything that I have to do. Most of the times I finish what I'm doing, before I start next task" (SN)

- "First I'm taking personal notes, which I write in the medical record when I have time" (SN)

- "My notebook is my best friend, and I have to carry it with me all the time." (SN)

Medicine delivery

- C-nurse is going to order medicine, but can't do it through the computer system since the medicine lacks a price indication and therfore she has to use the fax. Saying: - where are the forms for faxing now again? She takes out a folder and starts looking for the form. (O)

- Suddenly it's possible to order the medicine through the computer system, making the fax form unnecessary. The c-nurse logs off by remove her ID card. (O)

- At some wards the nurses always bring a computer on wheels or portable computer to the patient when doing medicine delivery. It is perceived as a convenient way to facilitate the recollection of the correct medicine and dosage. (I)

- "I think it's a danger when you are interrupted, especially during medicine delivery." (I)

- If the patient isn't by her/his bed when the medicine is divided, the mug is put on the bedside table. (O)

- When the PKV is exchanged, the nurse is going to the medicine room, to mix antibiotics ("the hardest one.") After mixing, it should stand un-

touched for about 15 minutes, and the nurse leaves the medicine in the medicine room. She is not making a note about the time. (O)

- A nurse says: "Nope, no one has taken the level of blood sugar on patient 8. " (walks there with a paper and a machine) She then makes a measurement and tells the level to patient and relative. (O)

- A nurse not only distributes medicine that is to be handed out directly, but also simultaneously prepares medicine that is to be delivered later during the day. (O)

- The nurse uses a computer system in the nurse room, to check the amount of medicine for each patient. She puts the pills in a small plastic cup with the patients room and bed written on it. (for instance 5:1) They have a medicine wagon with most those medicines in it, and the computer stands upon the wagon. (O)

- In the medicine room they have stocks of medicine and also those which have to be stored in a cold environment. (O)

- To find out if one medicine should be diluted, the nurse tries to read on the medicine packaging and ask colleagues. (O)

- A nurse asks a resource nurse if she could stand in the reception and monitor while the nurse is giving a patient medicine. Since the blood pressure was too low, the patient never got any medicine. When in the corridor the nurse meets the resource nurse who had forgotten about the monitoring: "Oh, I'm so sorry!" (O)

Patient and nurse communication

- At one ward the patients have the opportunity to give feedback upon their stay through filling out a form. The patients are informed but not urged to taking this action. (I)

- 95 % of this feedback considered treatment from health personnel. (I)

- "One problem is that nurse and patient have very different time perspectives. One day could have been very intense and stressful for the nurse, while the patient has been staring in the ceiling whole day." (I)

- Nurses have had training in talking about sensitive things with patients; they have had 7.5 hp compulsory credits in psychology and psychiatry. (I)

- The communication between nurses and patients is mainly oral and almost never in written form. (I)

- Nurse and patient talk mainly about anxiety, their current situation, their background, their treatment and future discharge. They also talk about common things as the weather, cats, family and things outside the hospital world. It varies between patients. (I)

- They also talk about the situation after discharging, practical things like homecoming and if they might need any help. (I)

- Some patients need emotional support, if they for instance have received life changing information. (I)

- Practically all nurses interviewed say that they would like to spend more time with their patients. (I)

- Occasionally nurses are told whole life stories by the patients, something they see as positive, a privilege of their occupation. (I)

- Some patients want to have everything about their body corrected at the same time when being in the ward, and the nurses then have to explain that's not possible or a priority. (I)

- At one ward the medical round meant that the patient (if possible) was moved to the expedition, which implied an increased integrity and facilitated the writing of the medical record. (I)

- Some nurses want to talk more about patient experience, "sometimes we just tell them how they should feel (according to values) but at the same time they can feel completely different" (I)

- "We call and nag radiology department to get a time for our patients. " This meant they got information about openings, and also they could tell the patients that they (the nurses) had tried and that the radiology personnel also worked as fast as they could. (I)

- At an Intensive Care ward, there is at least one nurse present in the room

constantly. (SP)

- A nurse asks a patient about the patient's social security number right before they connects the medicine to the patient, as an extra safety precaution to make sure the right patient get it. (O)

- A nurse asks a patient whether they have taken the blood pressure on the patient before, in what arm and how it went. The patient answers that it went well and on which arm. (O)

- When a relative sits next to a patient in a bed, the relative asks the nurse how they do when inserting needles, and the nurse shows and explains the procedure to the relative. (O)

- Sometimes relatives come to the ward to pick up medicine for a recently discharged patient. At such an occasion, the nurse leaves the room (the office) for 2 minutes to collect a medicine list for the patient. Meanwhile, I and the relatives stay in the room. When the nurse comes back, the relatives say that they don't recognise all the medicine so the nurse explains what is what to the relatives. They conclude that the list is a bit outdated and what medicines the patient should have. (O)

- One patient uses the nurse call, which the nurse receives. The nurse goes to the patient, is being asked by the patient to help them to reach a handle hanging from above, and the nurse moves the handle to be within reach for the patient. (O)

- During the round, the physician and the patients mainly discuss their situation and what might be the next steps in the procedure. (O)

- During the round the conversation mainly is driven by questions from the physician whom the patient replies. (O)

- When nurses and physicians speak to patients in their bed standing in a shared room, everyone in the room can hear what is said, giving very limited or no privacy for the patient. However, draperies can shield patients from view if they are pulled out. (O)

- Nurses seem also very empathic when speaking to relatives to the patients. Example: A relative calls a nurse on the phone. The nurse ensures the relative that the patient has got a higher painkiller dosage today and explains the nature of the pain. The nurse also says that the patient very much enjoyed the relative's visit earlier, and repeats that "you now you can call us whenever you want to, we are here day and night ('dygnet runt')".

Nurse to patient

- The patients often ask for a plan for their stay/care, and information about upcoming events and their health status. (I)

- The nurse asks the patient about emotional or physical reactions on the treatment. They also inform about coming events. (I)

- How strong the wish of receiving information about their hospital journey is differs a lot between different patients. Some patients want to know everything, while others do not want to know more than necessary. (I)

- If the nurse carries something out (medical/physical operation) on the patient, the nurse always explains what she is doing, even though if the patient might not be aware of the situation. The nurse is also explaining why she is doing this. (I)

- Sometimes the nurse knows things she cannot tell the patient since it is the physicians' task to share. If the patient then asks the nurse about that info, the nurse might have to withhold the truth for some time, meaning lying to the patient saying 'they don't know'. This is perceived by the nurse as a difficult yet necessary situation in some cases. (I)

- The nurses mainly talk about risk and health factors ('risk- och friskfaktorer') with the patient. (I)

- The nurses give the patients a list of their medication for the patients to take with them when they leave the ward to go home. (O)

- When writing in the computer system, one nurse is having a hard time figuring out what the patients real name is (due to her nickname) (O)

- Nurse says to patient (and relative) - Why do you have this button pressed so that you hear all the alarms? (Relieves the button) (O)

- The nurse says to patient: - Oh, your oxygen (tubing) have come into wrong place (moves it right) (O)

- The kind of information that patients want from the nurses while lying in a ward is: (SP)

  o An approximation of when different events are to take place. One patient says that "If it takes time, it is easier to accept if one knows it will, and above all, one wants to know you are not forgotten." Also, the patient feel like when an activity is taking place, no information about it is given beforehand. Another patient expresses this as "Since I was worried about the surgery, I wanted to have a lot information about time/planning. (…) It would have been easier if one had specific times to adjust to instead of just waiting and not knowing if it was 15 minutes of two hours left."

  o What event that is taking place at the moment

  o How long time it will take

  o One patient wants to feel like they understands what will be done so that they is prepared when it happens. "Sometimes it is a lot of people that you really don't have any idea about what they are doing or why, so I would perhaps like to have a better understanding of the process." The same patient says that "I would like to have information enough for me to feel more secure and gaining an increased understanding, but

keep it as short as possible."

o Patient: "Why everything is like it is" Another patient wants to know WHY for a lot of topics: Why the nurses ask about a specific pain area, Why it is important not to eat, and Why the nurses have to know if the patient has been to the bathroom.

o One patient says that "If one would have gotten an overview of what will happen right in the beginning of the stay at the ward, it would have been really nice so that one understands a bit and don't feel so disorien ted".

o How the x-rays look like (patient: "I would have liked to see the x-rays myself while a doctor could explain it to me simultaneously.")

o If the medical condition (injury/infection/surgery detriment) is healing as planned

o At an emergency department: When the physician would arrive (patient: "Since the nurses didn't know when the physician would come to me, they did not give me any information at all.")

o One patient didn't use any nurse call, but experienced the time before a nurse would come by and check on the patient, the uncertainty was a bit difficult to handle.

o "When I can go home, and when I will feel like normal again" (quote from patient)

o One patient wants to know what happens in the outside world (TV, newspapers, etc.), outside the hospital while being in the ward. The ward is perceived as isolated.

o One patient wants to know that the nurses are moving close by. "I had no need for talking or similar, but it gets lonely very quickly when you are lying "tied to a bed".

o One patient perceives the nurses being concise in their communication as something positive, "no unnecessary information that could cause worries". The patient's opinion is that he/she "doesn't have to understand the big picture, but trusts the nurses in that they know what they are doing".

o One patient (50-59 yrs) would have liked to have information about the timing of the nurses' shifts so that they didn't disturb them during hando ver.

o One patient (50-59 yrs) wanted to know if/when there would be a new physician visiting, and also how much time the physician has for the pa tient.

o One patient (50-59 yrs) requested a review of their medicine list, both the new and the old. "The old one because I wanted to be sure that I had got my medicine."

o One patient request access to its test results.

o One patient request a bit more detailed info about treatment and medicines.

o One patient wanted a bit more information from the nurses since they had just became parents for the first time, but the patient also thinks that perhaps the nurses didn't want to "disturb" them too much. The patient wanted to talk a bit about what had happen during the emergency surgery they had just had, and experienced that they did not get any chance to do that.

o One patient request more attention from the nurses.

o One patient thought the transmission of information (probably talking) sometimes to be a bit too quick.

o One patient "wants to be treated as a human being and not as a task".

• The kind of information that patients perceive as important to the nurses to give is: (SP)

o Guidelines for what the patient can and cannot do when being at home again

o How future treatment is to be performed

• One patient could look at TV in the ward and would have liked to be able to discuss football with the nurses while in the ward. (SP)

• A nurse asks a patient what they want to have for dinner and collects the food for the patient. (O)

• When a nurse is in a patient room, one patient nearly takes one of the pills on the table next to its bed. The nurse says: "No, the other pill! That is the sleeping pill!"

• One prescription for a patient's medicine is a chewing pill. The nurse comments this to herself while finding it in the medication room. "How fun is it to have a chewing pill when you don't have any teeth?" (O)

• A nurse sometimes let the patient be part of the task planning (prioritising). Example: A nurse asks a patient whether they can do another patient's night routine before coming to that patient. (O)

• A conversation about a nutritional drink: Patient says while getting a new glass of it: "This is really pure poison!". The nurse replies while finding something next to the bed: "Oh, but have you hidden it here, have you not?" ('Det här är ju rena giftet!', 'Nämen, har du gömt den här va?')

- A nurse informs the patient about what is done when it is done. Example: "Now I will put in a needle" ('nu sticker jag dig') (nurse - right before doing that).

- The patient informs the nurses about what they might want. Example: "I will call you if I need to go to the bathroom." (patient), "of course!" (nurse) (O)

- A nurse performs a test on a patient with a machine, since the machine is slow in delivering the result (approx.2 minutes since test), the nurse tells the patient that they will come back later and tell the patient the result. Right then, the nurse gets the result and instantly informs the patient about it. The nurse also wrights the result down (?) in a note book. (O)

- Patients sometimes want to see their own x-ray pictures. Example: Dialogue during round – "Do you want to see the pictures?" (physician) "Yes, please!" (patient) "Then we will print a picture for you." (physician) (O)

Patient to nurse

- Some patients do not know Swedish and therforee have to use an interpreter. (I)

- Sometimes a patient calls to the ward directly and says that "I want a bed" (at the ward). (I)

- A patient walks into the reception and asks if they could change antibiotics. They walk in the corridor and discuss the patients' furlough. (O)

- If the nurse can't respond to a question, the patient is asked to write it down and ask a physician later. (I)

- A relative to a patient comes in and says that the patients' feet are falling asleep. The nurse makes a note on this. (O)

- "They want to talk more about their future plan, also in long-terms." (I)

- "They want to make sure they are not forgotten or missed." (I)

- "A lot of patients are extremely well-informed" (regarding their own situation because they have read a lot on the internet, etc.) (I)

- A lot of patients asks about medicines, x-ray responses etc. At one ward the nurses then have to go outside the room to find the answer, which is unpractical. The nurses want to have such information more accessible. (I)

- At the wards investigated, they have only one kind of nurse-call. When a patient uses the nurse call, their issue can be everything from a coffee request to severe pain in chest. (I)

- At one ward the nurse call system was perceived as very adequate (and the nurses always responded to all alarms). (I)

- Sometimes the nurses cannot answer a call since they for instance are having a very sensitive conversation with a patient. (I)

- At one ward they had stopped using the installed paging system because they had difficulties remembering their own number (which was specified on computer screens at the desk.) (I)

- Conversations which are not of medical nature are not documented in the medical record. (I)

- A patient found it difficult to get in contact with the right personnel ("someone that knew anything" while lying in a non-intensive care ward. (SP)

- When patients want to talk to nurses about other topics than their medical condition, the following topics are mentioned by the patients. (SP)

    o Ordinary small talk, "Weather and wind"

    o News about "the outside world"

    o Funny anecdotes

    o The nurse's private experiences going through the same thing (beco ming a mum)

    o "It was nice that they asked about what I did during the days/for living."

    o Football (patient 20-25 yrs) (the stay at the ward coincided with the European Football Championship)

    o Nothing. "They should work to improve my condition. It should be as a Japanese factory, Lean production more or less. Talking and have a good time is something I rather do somewhere else with someone else."

- A patient asks a nurse whether there will be any physician at the ward during the weekend. The nurse replies that yes, there will be controls on Saturday and on Sunday. (O)

- When I am standing in the entrance of a patient room, one patient says to me: "Please, sit down here so you don't have to stand up!" and points next to her on the side of the bed. (O)

- A nurse says that it is positive that the patients tell what they want. Example of conversation: "No, not like that! (patient)", "oh, sorry! (nurse)" (O)

- The patients tell the nurses and physicians if they are in pain and the pain-killers are adjusted to that. Example: Nurse and physicians walk around on

the round to the patient rooms, and a physician asks a patient if the patient is in pain. The patient replies "I have such a pain I'll co crazy", and the physician then says that "We will raise the dosage painkillers" to the patient (which the physician is repeating at least 3 times during the dialogue). (O)

- When one patient gets a crème from the nurse and is told it is for the yeast infection, the patient jokes saying "yea, I have a little chantarelle cultivation in there". (O)

- A relative to one patient comes to the reception and says that the patient is having a headache. The nurse tells the relative that she will come with Alvedon, and walks to the ward room. Starts to talk with a colleague, some minutes later the patient is calling, and the nurse asks another colleague if she could go there with an Alvedon and look over the patient. (O)

Other obstacles and ideas

- Scheduling of staff (I)

- Incompatible software (ALL!)

- Curtains (I)

New technologies:

- One nurse/coordinator says that "It should be possible to do a lot with technical solutions to simplify the communication at the ward." The Department of Dermathology as Sahlgrenska has recently received an award for successful use of smartphones connected to a dermatoscopes. The referral times ('remisstider') have shorten dramatically since the physician can diagnose skin lesions without actually seeing the patient but only using the data collected by the dermatoscope along with a picture taken with the smartphone camera.(I)

- At one ward some nurses used their personal mobile phone as a flashlight, since the wards' flashlights were hard to find. The flashlight was mostly used to shine on patients pupillary during night shifts. (I)

- Real time information about patient EKG, etc. can be sent directly from an incoming ambulance to the hospital ward. (I)

Patient privacy.

- At handover in an office, a nurse says something about a patient. The door to the corridor is open so a colleague instantly points this out and the door is closed immediately. (O)

Stuff-related:

- Nurses have blue ascom phones with default ringtone on. Occasionally they use the loudspeaker function when talking with several colleagues on the phone. (O)

- The wards have a centrally placed staffing whiteboard where the nurses can write and see who is working on the shift. (O)

- Patients can if convenient bring their own TV – one patient have done that. To rent a TV from the ward during the stay costs 30 kr/day. The screen of the rented TVs are of quite poor quality. (O)

- At one ward they have telemetry screens in the ceiling of the office and in the reception. When writing medical records in the office, one nurse turns around, checks a value (?) on the telemetry screen in the ceiling of the office, turns back to the computer and types the value into the record. (O)

- A ward has ceiling screens in the corridor and small screens on the wall inside each room (next to the door) which shows which room is calling if a patient call is on. Otherwise the numbers "42,43,50,52,53" (ward 1) or the words "Desinficering, Behandling, Passage, Personal, Kök, Läkemedel, Passage, Personal" (ward 2) are looped after each other. The nurse do not know why these numbers are showed and do not know of any practical use of it for anyone else. It could be the names of the different units/rooms connected to the communication system at the ward. (O)

- A ward has a notepad lying in the reception where the nurses can write down tasks for the ambulant nurse ('springsköterskan') to handle. (O)

- Nurses continuously write down information about patients on notepads which they carry around with them throughout the shift. The medical records are updated towards the nurse's notes when convenient (during the shift). (O)

- At the intensive care ward at one hospital they have analogue medical records, which makes it necessary when transferring a patient from there to another ward to also transfer (a copy of) the medical record simultaneously. (O)

- At one ward, the nurse caries around an Ascom pager which receives alarms from the telemetry monitoring. It beeps/vibrates sometimes. However, at one occasion, it beeps and the nurse carrying it says "it is probably not a patient" and means it is disturbance. (O) The nurses perceive the telemetry device as somewhat "unreliable". (I)

- A nurse tries to use a machine to take a test on a patient, but the machine does not work. The nurse searches for the reason, discovers it, plugs the machine into the wall, takes the test on the patient, waits 30 seconds and receives the result. Says "done!" to the patient. (O)

- The nurse goes to a medication trolley, checks something in the computer which is placed on the trolley and writes it down on a paper. The nurse picks up medicine (only the nurse has the key to the locker) and plastic cups from inside the trolley and puts the pills inside each plastic cup. The bed number, the patient's first name, and which time the patient is to have the medicine in written on the cup with a marker pen. (O)

- The medication trolleys has one bin for each patient, with a sign saying the

bed's name (for example 2:1) (O)

- At the wards, they have a small stock of wheel chairs that are used inside the ward for moving patients. For example, a patient needs it to be able to go to the toilet. (O)

- A nurse collects a blood glucose meter but it does not seem to work as usual when taking "unplanned" tests (because of login?). (O)

- At one ward, they have daily staff meetings, showing the intranet on a projector wall in the lunch room. (O)

- At the oral info meeting with all staff, the nurses discuss a new machine and that every patient has to have it's ID on the arm in order to be able to scan it. (O)

- The nurses have to login to the medical records using their ID plastic card in a reader in the keyboard. The nurses discuss the problem of the info written not being saved when one urgently needs to leave the computer, since the info is not automatically saved if you remove the card. Perhaps could the nurses have the card in a cardholder with a strap, like lift passes?

- When working in the medication room, a nurse checks something in a binder in a shelf, and also calculates an amount on a pocket calculator.

- During the round, the physician looks at x-ray pictures of the patients on a computer. (O)

- During the round, a nurse says to a physician that sometimes the patients want to see their x-ray pictures so we could print those. (O)

- The physician dictates the medical record by using a computer-connected Siemens Dictaphone. (O)

Trivia (…?)

- At one ward at one occasion, two nurses find and remove a runaway drip stand (without it's patient) from inside the reception office space. None of the nurses know how it ended up in there. (O)

- At one ward at half past 8 at night, three patients (older men) look at the TV in the dayroom, smalltalking to each other. (O)

- A nurse asked to take a test on a patient, saying "I'm usually never taking tests this late at night but OK, I guess I can do that." while collecting the measuring equipment. (O)

- Doors – including to bathrooms – are rarely locked by nurses. Example: A patient comes out into the corridor wearing night clothes and wanting to go to the bathroom. A nurse tells the patient to check the bathroom closest which the patient does. When turning the handle, the door opens and the patient sees it is someone in there (since the doors to toilets are rarely locked by the

nurses when being in there with a patient). The patient closes the door again and is referred to another toilet by the nurse. (O)

- At one occasion, several nurses discuss who could do a task. One suggests a specific nurse, and another one replies that "that nurse is eating dinner right now". – Implying that it is not possible to ask the nurse who is on dinner brake. (O)

- Some patients like to stay in the ward: At handover, the nurse retells a recent discussion with a patient: (O)

    - For how long will I have this kind of thing? (patient)

    - Well, perhaps 6 weeks.

    - Oh, can I stay here for the 6 weeks?

- Another example of patients that like staying at the ward is the following dialogue between two patients: (O)

    - Nothing will happen today. Probably not tomorrow either. Are you also going home?

    - No, I hope not. I don't know when.

- At one ward, a transporter arrives with a set of trolleys to refill the storage in the medication room. The trolleys are 2 meters high, 4 in number and make quite a loud, rattling sound when being pushed through the corridor. A nurse nearby opens the door to the medication room for the transporter to enter (since it is only nurses who can and are supposed to enter the medication room), the transporter change the empty trolley to a full one and leaves the ward with the rest of the rattling trolleys. The procedure takes about 3 minutes.

- At the round, a physician sees that one patient has a tab open in its medical record for Abortion order (where the physician automatically comes when closing another tab), and comments that "the patient is quite old for that". A nurse replies that "It has happened automatically in the medical record system, it's an empty tab created by accident." (O)

- A physician confuses a patient with another patient with the same name during the round when walking to the patients. Then the physician says "so, it was the back!" to the patient but the nurse then points to the patient's leg showing a great bandage, saying "no, the leg!". (O)

- The nurses are empathic, and the patients tell them they appreciate it. Example: A nurse says that "I sometimes write 'Goodnight' on the medicine cup at night along with the patient's name and bed number, and one patient pointed it out to me today saying that it wanted to save the cup with the sweet message on. There you see how small things can matter." (O)

- Registration and intro talk ('inskrivningssamtal') is for an emergency ward done at the emergency department ('akutmottagningen') and not at the ward. (O)

- "It would be nice to automatically know if a patient had 0-HLR (meaning HLR shouldn't be performed in case of Cardiac Arrest) " (SN)

- At one ward they had a chair where the patients could be weight in, without having to stand up. (O)

- One patient had home care personnel with her: "world class luxury" said the nurse. (O)

Appendix 5: Swedish – English Healthcare Dictionary

Ward	Vårdavdelning
Inpatient care	Slutenvård
Outpatient care	Öppenvård
Cardiac ward	Kardiologi / Hjärtavdelning
Surgery department	Operationsavdelningen
Emergency department	Akutmottagningen
GP Healthcare centre	Vårdcentral
Nurse	Sjuksköterska
Nurse assistant	Undersköterska
Physician / Doctor	Läkare
Physiotherapist	Sjukgymnast
Nursing team	Vårdlag
Pager	Personsökare
Medicine delivery	Medicindelning
Medical records	Journal
PVC (Periferal venous catheter)	PVK (Perifer venkateter)

Appendix 6: Workshop Brainstorming

Workshop Brainstorming - Grupp A

Oskar och Linnea

Examensarbete på Teknisk Design på Chalmers

Vad vi ska göra på denna station:

-        Vi vill ha en massa idéer, fiffiga lösningar på era vardagsproblem i ert jobb.

-        2 Metoder, först: "Tänk er…"

•   Påminnelsemanick   - hur, var, när, varför?

•   Fotografiskt minne

•   Karta över var allt och alla är   - avstånd, rum, upptagen…

Andra metoden:

"Lite mer specifik situation"

•   Avbruten/Störd i en uppgift

•   Patientkommunikation/-resa

•   Överlämning mellan skift (?)

Workshop Brainstorming - Grupp B

Oskar och Linnea

Examensarbete på Teknisk Design på Chalmers

Vad vi ska göra på denna station:

-        Vi vill ha en massa idéer, fiffiga lösningar på era vardagsproblem i ert jobb.

-        2 Metoder, först:

"Tänk er…"

- Skärm i A4   - Visa vad som helst (det du önskar), Magisk upphängning, bärbar, vem, när?

- Digitalt armband på patient   - Positionering, kommunikation, vibrator, sensor, mm.

- Black box   - Professor Balthazars universalmaskin: Input -> Output

- Något du tänkt på och skulle vilja ha

Andra metoden:

"Lite mer specifik situation"

- Patientkommunikation/-resa

- Överlämning mellan skift

- Avbruten/Störd i en uppgift (?)