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Design of a health issue focused patient overview

A user-centred approach to increase situation awareness

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Abstract

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The implementation of electronic patient records has over the years become an international issue, as is the challenge to reduce the number of medical errors. The use of electronic patient records is viewed as a potential means to achieve patient safety and high quality care, but it is not uncomplicated to introduce a new system in healthcare. Implementing IT applications into healthcare appears to be a politically textured process of organizational change; it requires that the users are put in the centre during development if the implementation shall succeed.

This Master of Science Thesis is the result of a user-centred study that has been carried out at Cambio Healthcare Systems AB between September 2007 and February 2008. The thesis discusses how a patient overview based on health issues can be designed to give the care improved giver situation awareness. The fundamental idea of the overview is to support cross professional work that follows the patients' way through the whole healthcare system. User-centred methods were applied to examine the work flows at a geriatric ward, and to design different conceptual design solutions.

The thesis shows that it is legible that an overview of the patient's health issues would be useful in the aim of improving situation awareness. On account of the geriatric ward's characteristic teamwork it would be of most use to introduce an overview shared by all users. It would facilitate improved ways of communication, and provide the opportunity to create a shared mental model of a patient's health condition.

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Populärvetenskaplig sammanfattning

Svensk sjukvård är en sektor med höga krav på god vård, säkerhet och sekretess. Det är vidare en sektor där informationsteknologin tagit ett stort språng in på banan.

Examensarbetet är en del i ett större utvecklingsarbete som pågår inom Cambio Healthcare Systems AB där syftet är att öka stödet för ett tvärprofessionellt och processorienterat arbetsätt i systemet Cambio Cosmic. En viktig byggsten i detta utvecklingsarbete är införande av ett objekt som representerar patientens hälsoproblem, det vill säga den anledning som gör att patienten sökt vård. I många av dagens elektroniska journalsystem är informationen organiserad kronologiskt. Genom att organisera informationen i systemet kring hälsoproblem skulle användaren istället få möjlighet att tillgodogöra sig semantiskt organiserad vårdinformation.

När hälso- och sjukvårdspersonal söker vårdinformation kring en patient utgår de ofta från aktuella och/eller tidigare hälsoproblem. Beroende på hur informationen är organiserad kan detta vara förhållandevis lätt eller ganska svårt att få fram. I en pappersbaserad journal kan information vara ”utspridd” på olika enheter, de olika professionerna kan dokumentera på separata blad osv. En elektronisk journal kan även den ha informationen organiserad kronologiskt eller per profession, men den kan också vara problemorienterad och då snarare följa patientens hälsoproblem.

Syftet med examensarbetet är att, utifrån användarcentrerade metoder, ta fram ett konceptuellt designförslag på hur hälsoproblemsobjektet skulle kunna visas för användare på en allmängeriatrisk avdelning. Studiens primära frågeställning är ”Hur kan en patientöversikt baserat på hälsoproblem designas för att ge vårdgivaren ökad Situation Awareness?”.

Studien visar att en hälsoproblemsbaserad översikt skulle underlätta informationsinhämtning om en patient och dennes sjukdomar. Vid en geriatrisk vårdavdelning bidrar översikten även till förbättrade kommunikationsmöjligheter samt möjlighet för samtliga vårdgivare att skapa en gemensam mental bild över patientens hälsotillstånd.

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Sofia Persson

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1. Introduction to the field

The first chapter of the thesis outlines an introduction to the study. The political arena that controls the development of IT-systems in healthcare is presented as well as crucial projects that have influence on the development. A brief introduction to Cambio Healthcare Systems AB is also outlined – the company in which the thesis has been performed.

1.1 EPR, Electronic patient records, on the political agenda

The use of electronic patient records, EPR, and IT-support in healthcare has increased rapidly over the last decade. This is also legible when taking a look at the political arena, the governments agenda is at many ways focused at eHealth. An example is the "National IT-strategy for health and care" which aim is to facilitate deep collaboration on a national foundation. The objective is that the IT-strategy shall be implemented by the government, the county councils, the municipality and other hospitals and associates with connection to healthcare. (Regeringen 2007) Another example of political interest in EPR is a Swedish project called "National patient overview". The overall aim is to enable exchange of information; independent of where the patient is located s/he shall get the chance to see information from the total medical journal. The information shall contain critical care information, and be presented as an overview for both patient and physician. This project is part of the earlier mentioned "National IT-strategy for health and care". (Carelink 2007) The Swedish initiatives in EPR is not unique, there is also an increasing interest at the international arena. In 2007 the European Union started an eHealth project called "Smart Open Services" with the aim to enhance the European development of EPRs. (Malmer 2007 p 10)

When developing a sustainable IT-system to healthcare it is crucial to have a standardized (shared) conception of the care process as a starting point. A standardized model is important since healthcare is a complex activity, with different actors and organizations. This was the background to a Swedish project for modelling healthcare activities; which started in 2001 with the aim to agree on a national process model. The project was called SAMBA (SAmverkan, Begrepp och Arkitektur) and resulted in a description of the process when a patient is cared at medical division/s. The description can be used in any kind of ward and is supposed to make the communication easier between care givers and the suppliers of IT-support. (Carelink 2008)

The SAMBA-project also defines some critical terms that are widely used in the healthcare sector. It is fundamental that all involved persons know the standard definition of these terms. *Health issue* is an example of a term that has been discussed in the SAMBA-project. It is though a term that is problematic, it can be defined either as a condition that require health care activities, or according to diagnosis's defined in ICD-10[1] or as bigger groups of diseases (i.e. metabolic syndrome, abuse, depression, psychosis, asthma, trauma etc). This thesis is based on the definition finally defined in the SAMBA-project, and the definition can be read under chapter 2.1.

[1] The ICD is the international standard diagnostic classification for all general epidemiological and many health management purposes. ICD-10 was endorsed by the Forty-third World Health Assembly in May 1990 and came into use in WHO Member States as from 1994. The classification is the latest in a series which has its origins in the 1850s. (World Health Organization 2008)

1.1.1 Cambio Cosmic

Cambio Healthcare Systems AB is a Swedish company that has distributed healthcare administration systems since 1993. The vision of Cambio is “to create healthcare solutions that support exceptional care at every stage of a person’s life”, with a product called Cambio Cosmic. Cosmic stands for **C**ompliant **O**pen **S**olutions for **M**odern **I**ntegrated **C**are, and consists of a platform/engine called Cosmic Spider which is connected to different modules. The modules support care documentation, order management (lab and referrals), e-Prescribing, patient management, resource planning and care administration including billing, digital dictation and a data warehouse.

Cambio has approximately one hundred employees and offices in Stockholm, Linköping, Paris, London and Colombo. The system Cosmic has about 50,000 users in general and university hospitals, primary care clinics and specialist units. (Cambio Healthcare Systems AB 2008)

2. Objectives

The second chapter of the thesis presents the aim of the thesis, the target groups of the thesis report and of the prototype, the methods and delimitations. Under the chapter's final subheading one can find reading advice for the following chapters in the report.

2.1 Aim of the thesis

The thesis is part of a project at Cambio Healthcare Systems AB, which purpose is to support a process oriented workflow in Cambio Cosmic. It has been clear that a new object has to be implemented to support this extended process oriented workflow – an object called "health issue" (further on called HI-object). The object represents the patients' health issue, in other words which health condition the patient is seeking care for. These problems may for example be stomach ache, a broken arm or cough. By using a different structure, the usability of the patient record system can be improved. Today many users report difficulties in obtaining a good overview when opening a patient's record.

The SAMBA-project and the Swedish Standards Institute, SIS, define *health issue* as a health condition in the patient's health that may require public medical service. A health issue must not always be defined as an illness or injury; it can also include the demand of certificate of health, medical examination and other health conditions that may cause the need of medical services such as a pregnancy. (Swedish Standards Institute 2007)

The patient records of today are mostly sorted chronologically, and the care givers get an idea of the patient by browsing/reading the latest medical record notes for the patient, and backtracking through the medical record to get a clear picture. This may be more or less easily achieved – dependent on how the information is organized. By organizing the information semantically, by health issues, it is offered an increased possibility to seek information, document, prescribe and to follow the process of diagnosis, treatment and follow up. A semantic sorted patient record may facilitate a more process oriented and an interdisciplinary perspective on work, where care givers can incorporate diverse information about a health issue.

The aim of the thesis is to examine how a future HI-object could be applied into a patient overview. The purpose is to support the care givers to easily and quickly get an overview of the patient and his/hers health issues, and to be well aware of the patient's actual situation. The overview should not only give background information, it should also provide a solid foundation when planning future treatments. In other words, to facilitate the care giver improved situation awareness. Care givers are in this context equal to all actors with a care relation to the patient, they may be physicians, nurses, nursing auxiliaries, occupational therapists, physiotherapists or psychologists etc.

A further aim of the thesis is to analyse the patient related activities at a hospital based department with institutional care, and to discuss how an overview based on health issues could be used at this department – based on the different user groups' requirements. I examined the geriatric ward at Uppsala University Hospital[2], seeing that the geriatric patients often have a long medical record which may benefit a semantic order of information. The activities connected to health issues were charted through contextual observations and supplementary interview questions. Analyses of the ward's

[2] Uppsala University Hospital is Sweden's oldest university hospital; the first department was established in 1708. Today it has around 40 departments and over 8 200 employees. (Akademiska 2008)

work lead to proposals of design concepts of how the HI-object could be seen in a patient overview.

2.1.1 Problem specification

The thesis aims to discuss the following objectives:

- How can a patient overview based on health issues be designed to give the care giver improved situation awareness?
- Would a health issue overview be useful at a geriatric rehabilitation ward? In which processes?
    - What kind of requirements have the care givers at the ward, concerning information connected to health issues?

2.1.2 Aim of the overview

The design concept shall support a cross professional work that follows the patients' way through the whole healthcare system. A fundamental hypothesis is that the care giver can treat the patient more effectively and guarantee a higher level of quality care when s/he is given the opportunity to see a patient's total health background. The care giver shall also be given the opportunity to follow a specific health issue's processes in more detail. Hence is the aim of the overview to support the care giver during the daily work with an inpatient. It would also support the care giver in the beginning of the care period – s/he would then be given the opportunity to quickly understand the patient's actual and previous health condition.

The overview shall, with other words, support the care giver to understand the actual situation, in sum – to improve the care giver's *situation awareness*. The care givers at a geriatric rehabilitation ward are interested in the total picture of the patient's health issues, simultaneously they are in need of professional specific information (such as medical lists or care plans). It is therefore important to provide a health issue object that claims both kind of information. Situation awareness requires that all relevant information is available and presented simultaneously.

The overview further aims to improve the patient's confidence in the care giver. The care giver would not have to ask the patient about previous HI-activities, since all information connected to the actual health issue would automatically be in full view.

Technical preconditions of implementing a HI-object

The HI-object should, from Cambio's point of view, be able to interact with all kind of information about a patient – it will connect to all of Cosmic's modules. The current version of Cosmic lacks such a natural node. (Wiman 2007) A HI-object that contains all health issue-related information would simplify the information retrieval.

2.2 Target group

The prototypes which this thesis ends in have several target groups. One of the target groups are care givers trying to understand a patient's health issue, and actors trying to get a picture of a patient's medical history.

Another target group of this prototype is the care givers that know what kind of health problem the patient is seeking for, and by then want to treat a specific health issue. This group may be the same individuals as described above, but in another care process. The thesis is based on the requirements of care givers at a geriatric ward, but

the design concept is in the future supposed to function to any care giver at any institution.

Target groups of this thesis report are staff at Cambio Healthcare Systems AB, as well as people interested in Human-Computer Interaction and user-centred design, and students at the Master of Science programme “Socio-technical engineering”.

2.3 Method

This report rests mainly on literature studies and interviews. The initial phase of the project aimed to gain knowledge about the relation between Swedish healthcare and IT systems. Research papers, political information and meetings with persons with experience of the business provided a solid background to penetrate the area. Further on, profound information related to user-centred design was obtained mainly through literature studies. Special focus was made on the ISO-standard 13407, Beyer and Holtzblatt’s theory “Contextual design” and Ottersten and Balic’s theory “Effect managing”. The method Contextual Design consists of several phases, whereas this thesis focuses more on the methods first phases. The last phase in Contextual Design, to “put a new design process in place”, were for example not performed at all, since an optimal prototype has not yet been designed. It is necessary to evaluate further prototypes against the requirements, and it is not reasonable to start the last phase until a satisfactory solution has been designed. Ottersten and Balic’s method is fairly new and was applied in a way that I found most applicable to my study.

Several academic articles related to Problem-Oriented Medical Records, Situation Awareness, Cognitive Psychology and Interaction Design were also used.

How the study was conducted in detail can be read in chapter 5-8. The method plays an important role in the report which is natural since the study was focused on user-centred system design.

2.4 Delimitations

Introducing a new health issue object might lead to a completely different medical record, based on health issues. It is though of importance to emphasise that the thesis is limited to examine how the health issue object can be seen in a specific view – the *overview* of a patient and his/hers health issues.

The thesis does not further take into account any technical limitations, nor a solution to the handling of connecting different modules to each other. Due to the thesis’s shortness of time, limitations concerning participants and the number of interviews had to be done. It is though of importance to clarify that the number of participants suited my aim, even though it is always better to meet as many users as possible. The limited time span had also impact on the number of iterations that could be made – in optimum, the same procedures and methodology should be done several times. Iteration is one of the key criteria of user-centred system design.

2.5 Disposition

The thesis is written in English with reference to Cambio Healthcare System’s official company language. The study was though performed using the Swedish language, a different language than the respondents’ mother tongue could have affected the answers and possibly caused bias in the result. Consequently are all prototypes and other paper based methods worked out and designed using the Swedish language.

The following text describes the thesis's disposition and gives a brief introduction to each following chapter. To summarize; chapter 3-4 provide the thesis's theoretical framework whereas chapter 5-8 constitute the methodology of the thesis and the thesis's continuous results.

Chapter 3 Research summary and theoretical background

Chapter three aims to introduce the reader to the theoretical framework of the thesis. The framework consist partly of theories concerning perception and attention of information, where conceptions such as *mental workload, situation awareness* etc are introduced. The chapter also gives a research background to the area *Problem-oriented Medical Records, POMR,* which is a theory that advocates a medical record sorted by problems.

Chapter 4 Theory of methods

Chapter four gives a theoretical background to the user-centred methods used in chapter 5-8, and can thereby be seen as a map towards the following four chapters. The reader will be introduced to the field Human-Computer Interaction, with the central conceptions *usability* and above all *user-centred system design*. A user-centred system design process according to the standard ISO 13407 is outlined, and related methods are described.

Chapter 5 Understand and specify the context of use

This chapter constitutes the first phase in ISO 13407, and describes how I examined the context of use during my first studies at the ward. The chapter also presents the results from this first activity. The users of a future HI-object are described as well as their fields of responsibility, their work tasks and context.

Chapter 6 Specify the user and organizational requirements

The next phase of the study was to analyse the data from the contextual inquiries, which is described in chapter six. Apart from the analysis results, it is also described how the analysis was performed. The use and result of Ottersten and Balic's method effect map is described in this chapter.

Chapter 7 Produce design solutions

The third activity in ISO 13407 is described in chapter seven; the chapter presents how the conceptual prototypes were produced at different levels. Apart from describing the prototyping process it also shows the final prototypes that were later on evaluated with the end users. Figures are shown and descriptions of each component can be found in the later part of the chapter.

Chapter 8 Evaluate design against requirements

Chapter eight describes how the evaluation was performed; what constellations of users and which evaluation methods that were used are also presented. Finally, the results from the evaluation sessions are outlined.

Chapter 9 Discussion

This chapter aims to discuss the conceptual design; discussing the overall advantages and disadvantages of the prototypes and how the design can be improved. In chapter

nine I also discuss the problems of implementing a HI-object, a computerized POMR. The problems are related to the definition of “health issue”, and how to deal with a patient’s privacy and secrecy. The chapter ends with some recommendations of further studies.

Chapter 10 Conclusions

The last chapter presents the conclusions of the thesis, which can be seen as answers to the thesis’s opening objectives

3. Research summary and theoretical background

Chapter three provide the theoretical framework of the thesis, after a short introduction to previous studies in the field. The sociotechnical approach to EPR is described as is the history of Problem-oriented Medical Records, POMR. Theories concerning attention to, and awareness of, information are briefly described.

3.1 A sociotechnical approach to EPR

The implementation of EPR has over the years become an international issue, as is the challenge to reduce the number of medical errors. The use of EPR's is viewed as a potential means to achieve health safety, but it is not uncomplicated to introduce a new system in health care work practices. (Ash et al 2004, p 104) Morris Collen wrote in 1995 an historical survey of medical informatics, and concluded with the following phrase

> "Developing a comprehensive medical information system appears a more complex task than putting a man on the moon had been". (Berg 1999, p 87)

Berg points out in his article *Patient care information systems and health care work: a sociotechnical approach* (1999) that implementing IT applications into healthcare appears to be a politically textured process of organizational change, and it requires that the users are put in the centre during development if the implementation shall have any chance to succeed. Using the sociotechnical approach, work practices (as healthcare) are seen as networks of people, organizational routines, tools, documents and so forth. A ward is seen as an interrelated assembly of humans and things that are functioning to deliver patient care – roles and tasks are only part of a network. A physician is for example only a physician in the network where s/he is a part, without the other entities of the network s/he cannot work as a physician. The tight interrelation between entities is often reflected when introducing a new entity to the system – such as a system for EPR. Changes in the network demand changes in the hospital architecture. Hence, it may give grave consequences if one separates the network into a "social" and a "technical" system. According to the sociotechnical perspective, the element should be dealt with as a whole! (Berg 1999, p 89)

Berg also concludes that a crucial first step towards powerful and artful patient care information systems is to approach healthcare practices as a heterogeneous network, and to recognize the pragmatic character of the care givers' work. (Berg 1999, p 98) The nature of healthcare work is fluid and cooperative, while IT-systems are often functioning in a formal, standardized and comparatively rigid matter. IT applications that only allow certain modes of data input or tools that include pre-fixed steps would fordo the characteristic needs of healthcare work. (Berg 1999, p 97) To develop any IT application it is extremely important to gain empirical knowledge about the work patterns and the context. Berg advocates qualitative research methods, and specific: participant observation. (Berg 1999, p 93)

One of the advantages with the use of EPR's is the possibility to store a large amount of information. But problems may occur if the interface is not organised in a matter related to the care giver's tasks, it may then lead to information overflow. If the user has to switch between different screens to see all relevant information, it results in a loss of overview. The user may also risk missing some information, if the load of information is unnecessary large. (Ash et al 2004, p 107)

3.2 POMR, Problem oriented medical record

Lawrence Weed introduced in 1969 a new way of ordering the medical records, where the information was sorted by problem rather than more commonly chronological order. Weed's problem-oriented medical records (further on called POMR) focuses on one or more of the patient's problems – it should be immediately clear to which problem the findings and the treatment plan concern. The medical record should, by POMR, be sorted systematic according to SOAP; the patient's own story (**S**ubjective), clinical observations (**O**bjective), test results and conclusions (**A**ssessment) and plan for treatment and care (**P**lan). The medical data is furthermore organized in four different parts: problem list, defined data base, initial plan and progress notes. All plan and progress notes are tagged to one or more problem(s) in the problem list. (Bemmel 1997, p 102)

Claus Bossen made a study in 2007 where he evaluated the use of computerized POMR in a Danish clinical practice. His conclusions were that a computerized POMR may provide a description of how physicians think or ought to think, but in reality it did not adequately support the complex clinical work. He pointed out that the POMR is more suitable to patients with few, simple problems than to patient's with a complex set of problems. The users also mentioned that the medical information became too fragmented, and it was hard to get an overall picture of the patient. The users appreciated the problem list in general, but were discontent in some point since the list did not give any indication about possible interrelations between different problems. Some users also hesitated about where to place information, it is not uncommon that health activities cut across different health conditions. (Bossen 2007, p 596)

To sum up, the thoughts behind POMR are well-developed in theory but have been proved to be more complicated when practically trying to implement it. Computerized systems have though seemingly many advantages in comparison with paper based journals – such as the ability to link information to different health issues, which is impracticable in the paper based versions. This thesis will examine if, and how, POMR would function in an actual electronic patient record – Cambio Cosmic. Cambio Cosmic is today a chronologically ordered medical record system.

3.3 Mental models of a system

An important characteristic of computer-aided work is the dealing with human decision-making. Hence, it is essential to understand how decision-making is performed. Users that manage a certain process need the following criteria to be fulfilled:

1. A clear *goal* must be obvious.
2. Understand how the process is working, the user needs a *model* of the system.
3. Have enough opportunities to influence the state, it shall be *controllable*.
4. Have enough information about the process actual state, it shall be *observable*.

When designing an IT-system it is of great importance that the researcher describes, analyses and understands aspects of human decision-making. If all of the mentioned conditions are not fulfilled, the consequences will be serious. It will not be possible to steer the dynamic process as intended – it will be the case if, for example, the user

cannot observe all necessary system states, or if the user's model of the system is incorrect. (Gulliksen & Göransson 2002, p 90)

The *mental model* describes the user's conception of the implemented software; it is furthermore the user's comprehension of the relationship between input and output. Donald Norman (1983) describes the mental models as naturally evolving models; people formulate mental models of a system through interaction with the actual target system. (Norman 1983, p 7) The mental model is used to mentally simulate the outcome of an action. If the mental representation of the system is inadequate, it may lead to serious misunderstandings. To improve the user's apprehension of the system it is for example possible to represent the system with image representations or spatial models. Persons who appreciate such spatial models are, according to Procter and Van Zandt's theories, called "imagers". (Procter & Van Zandt 1994, p 463-465) Norman argues that the mental model must not be technically accurate, but it must be functional. (Norman 1983, p 7)

3.4 Situation Awareness

Situation Awareness is formally defined as "The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future". (Endsley et al 2003, p 179) Fundamentally, Situation Awareness means being aware of what is happening around you and understand what the information means to you now and in the future. Situation Awareness can be defined as three steps where one shall have the knowledge and possibility to:

1. Identify the states of the environment/process
2. Analyse and comprehend these states (to understand the process)
3. Make predictions about the future states

(Endsley et al 2003, p 14)

Blandford and Wong (2004) argues that a good Situation Awareness is crucial in decision making; they further discuss that technology is a common tool that can be used to improve Situation Awareness in dynamic and information intensive environments. (Blandford & Wong 2004, p 423)

3.4.1 Peripheral awareness and selective attention

People maintain awareness through both selective attention to some features and through peripheral awareness of others. People are in general aware of much information that is not in their current focus of attention; this peripheral awareness enables people to switch attention to new matter if it becomes salient to them. (Blandford & Wong 2004, p 424)

It is common to use the term awareness in relation to what information is important for a particular job – only those pieces of the situation that are relevant to the actual tasks are important to enhance Situation Awareness. (Endsley et al 2003, p 13) Humans' ability to attend to stimuli is limited, which implies that the direction of attention determines how well we perceive, remember and act on information. Proctor and Van Zandt (1994) explain the conception *mental workload* as the amount of mental work or effort necessary to perform a task. The mental workload increase with the task demands; the user's performance may suffer if the mental workload is too high. (Proctor & Van Zandt 1994, p 199)

Information that does not receive attention have little influence on performance, it is though important to direct attention to information that is useful for a specific situation. (Proctor & Van Zandt 1994, p 187) I let some obvious, but although important, words from Preece et al (2002) end this chapter:

> "The way an interface is designed can greatly affect how well people can carry out their tasks" (Preece et al 2002, p 104)

4. Theory of methods – user-centred system design according to ISO13407

This chapter aims to introduce the reader to the user-centred design process, with special attention to an ISO-standard. It furthermore presents explicit user-centred methods such as contextual inquiries, affinity diagrams, effect maps and design theory. This chapter can be seen as a map to approach chapter 5-8, which describes my applied procedures and results for each step of the ISO-standard.

4.1 What is user-centred design?

User-centred design is based on knowledge from the field Human-Computer Interaction, HCI. HCI is a discipline that focuses on the interaction between human and computers; the ACM's Special Interest Group on Computer-Human Interaction defines the discipline with the following words:

> "Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them." (ACM SIGCHI Curriculum Development Group 2008)

A central concept of HCI is *usability* – systems development shall ultimately return systems that are usable (with effectiveness, efficiency and satisfaction) to a specific set of users with a specified set of tasks in a particular environment. (Göransson 2001, p 19)

Usability can be related to the concept "qualities in use", which Löwgren describes as "certain properties of a digital design that are experienced in its use". (Löwgren 2002, p 1) A product's qualities in use are dependant on its structural, ethical, aesthetical, communicative and instrumental properties. All of these properties must be prioritized against the others when estimating the qualities of an IT artefact. (Löwgren & Stolterman 2004, p 6)

Since usable systems cannot be taken for granted, usability must be a considered as a natural inevitable ingredient in system developing; hence a *user centred system design* (UCSD) should be applied. Norman and Draper introduced the term UCSD in 1986, and defined it as:

> "User-centred design emphasizes that the purpose of the system is to serve the user, not to use a specific technology, not to be an elegant piece of programming. The needs of the users shall dominate the design of the interface, and the needs of the interface shall dominate the design of the rest of the system.". There are several definitions of the term, but the common statement is that the development process shall focus on the users and their needs. (Göransson 2001, p 28)

To sum up with Göransson's words: "user-centred design is a *process*, and to be user-centred is an *attitude*". The standard ISO 13407 describes a user-centred design with the following words:

> "An approach to interactive system development that focuses specifically on making systems usable. It is a multi-disciplinary activity, which incorporates human factors and ergonomics knowledge and techniques. The application of human factors and ergonomics to interactive systems design enhances effectiveness and efficiency, improves human working conditions, and counteracts possible adverse effects of use on human health, safety and performance. Applying ergonomics to the design of systems involves taking account of human capabilities, skills, limitations and needs.". (Göransson 2001, p 36)

4.2 ISO13407 "Human-centred design processes for interactive systems"

The standard ISO 13407 is used to ensure software quality in product development, by incorporating user centred design activities throughout the life cycle of interactive computer-based systems. The standard consists of four user centred activities that needs to be performed iterative, until the specified user oriented objectives are satisfied, see figure 1 below. (BS EN ISO 13407:1999 p 3)

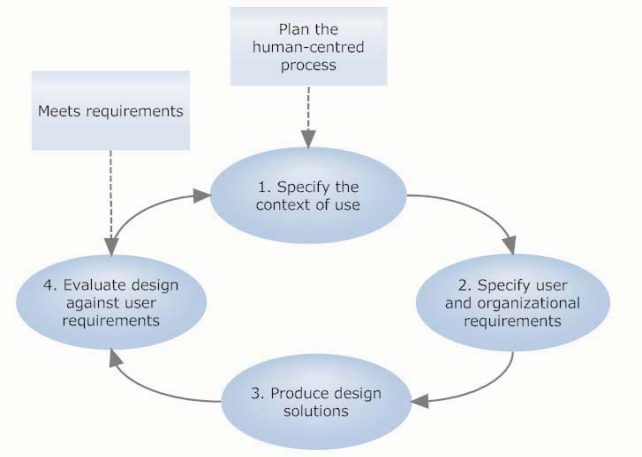


Figure 1: Human-centred design process according to ISO 13407

4.2.1 Understand and specify the context of use

This activity includes understanding and specifying the context of use, to make it explicit. It requires involvement of users since the designer needs to get a picture of their characteristics, the involved tasks and the physical, technical and organizational environment where the users will utilize the system. It is important to identify the details in this context in order to guide early design decisions. (BS EN ISO 13407:1999 p 6)

To be able to understand the users' work situation the researcher can make *contextual inquiries*; a method that Beyer and Holtzblatt describes in the book

Contextual Design (1998). Their theory says that design should be based on the way the users are, or wants to be, doing their day-to-day work. Contextual inquiries means that the researcher studies the users' work demand in their real work environment. The authors mean that it is possible to see underlying, hidden, work structures only through deep contextual inquiries. (Beyer & Holtzblatt 1998, p 43)

Alan Cooper, the author of Face 2.0 (2003), also states that the most effective technique for gathering qualitative user data combines interview and observation. The technique called observation interviews allows the interaction designer to ask clarifying questions about the situations and behaviours they observe in real-time. (Cooper 2003, p 43-44)

Blomberg, Burrell and Guest (2002) mean that one of the fundamental axioms in the social sciences is that "what people say they do and what they actually do are not always the same". Several studies have shown that verbal protocols are often inconsistent with the actual behaviour. (Blomberg et al 2002, p 969) Observation interviews can be a good way to understand in which context the user is working. When observing users in their work environment, in situ, it may be possible to discover more underlying characteristics than in an interview, since it may be difficult for the user to describe his or hers activities or habits in concrete words. An objective observer has the possibility to see things different from the user's perspective, it is thought important to have in mind that the user will or might be affected by the presence of an observer; this may alter their behaviour in some extent. (Benyon et al 2005, p 222-223)

Preece, Rogers and Sharp (2002) emphasize the importance to have a framework when being an observer in the field. A conceived framework helps to guide the observer when the events in the field are complex and rapidly changing; it gives the observation structure and focuses the observation. (Preece et al 2002, p 368-369)

According to Blomberg et al (2002), the researcher can become integrated into the scene at varying degrees. The researcher may act as an *observer-participant*, where s/he behaves as quietly observing and unobtrusive as possible. S/he may at the other end behave as a *participant-observer*; actively involved in the events observed. To make profit of both roles, the researcher often moves between these two extremes. (Blomberg et al 2002, p 969)

4.2.2 Specify the user and organizational requirements

The next activity's focus is specifying the functional and socio-cultural requirements for the system. When doing this it may bee appropriate to:

- Identify all users and others that will be affected by the design
- Clarify the objectives of user-centred design
- Prioritise the different requirements
- Define comparable goals against which the design shall be tested
- Get confirmed by the users or by the ones representing their interests (BS EN ISO 13407:1999 p 8)

Affinity diagram

Beyer and Holtzblatt (1998) describe a method called *consolidation,* which is used to bring data from different users together. It can be a useful method when trying to produce a single picture of the population a system will address. To be more concrete, consolidations are done by pulling individual data together and ultimately see the work of all users. To consolidate the data (master the structuring of data) a technique called *affinity diagram* can be used. It is a useful method for identifying the patterns in

qualitative data. (Snyder 2003, p 248) Affinity diagrams can either be made by the design team (as Beyer & Holtzblatt prefers) or by the users themselves (as Benyon et al prefers). (Benyon et al 2005, p 482)

The basic processes in this method are to put up one note, then to look for other notes that seem to go with it. Two notes have an affinity if they are saying similar things about the work – they are expressing a similar intent, or an issue in the user's work. Notes that are collected together are given a name to represent the group, a label. A good label states the work issue that holds all the individual notes together; it is a succinct phrase that summarizes the content of the group.

> "The affinity is built bottom up, by raising common structure and common themes out of the individual notes captured during the interpretation sessions." (Beyer & Holtzblatt 1998, p 156)

When well written, the labels (group names) tell a story about the user, structuring the problem, identifying specific issues, and organizing everything known about that issue. (Beyer & Holtzblatt 1998, p 161)

Effect maps to guarantee that the desired effects will be met

Another method for structuring data is Ottersten and Balic's (2007) method *effect maps* – it is a structured way to pin point the expected effects of a new solution. The effect map can also be a useful starting point for the design work. (Ottersten & Balic 2007, p 46) The idea of effect maps is that the desired effects are made by the users of the product, and it is therefore possible to describe different target groups' user goals with the same product.

Figure 2 below shows the structure of the effect map, it may be larger or smaller but the overall structure is always the same. The top node shows the *purpose* of the new product – why it should be implemented. The persons below represent the different target groups of the product, which in turn have usage goals (the goals may be shared between different target groups). The bottom of the figure shows which actions need to be done with the product to fulfil the upper usage goals. (Ottersten & Balic 2007, p 47)

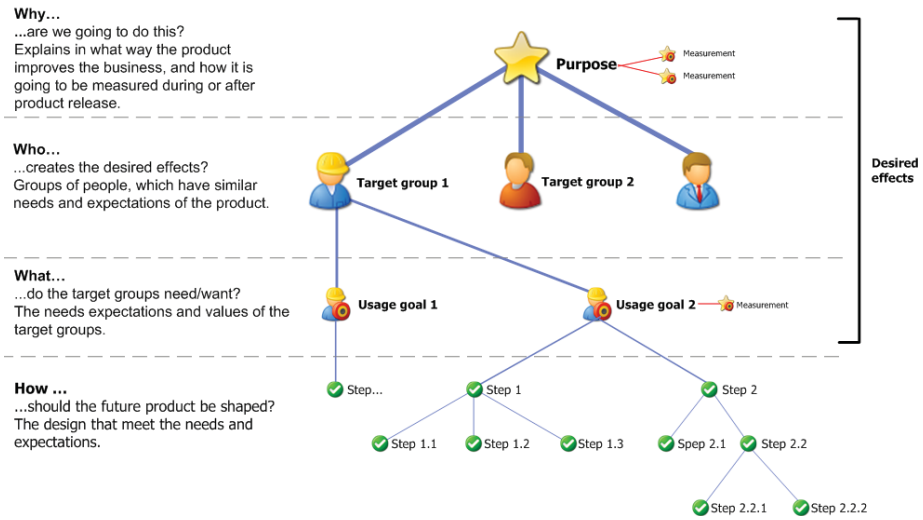


Figure 2: Schematic figure of the parts that construct the effect map (InUse 2008)

The effect map is a specification of requirements; which only includes those parts of the product that have an observable impact on the desired effects. The method is a way to describe the link between the desired effects and the selected design. The method aims to simplify the process to understand the choice of design – those design aspects that does not have a clear measure in the effect map should not be implemented in the new release. All design aspects should therefore be visible in the map! (Ottersten & Balic 2007, p 47-48)

Work redesign (scenarios)

When specifying the requirements it is appropriate to control these with the users. Beyer and Holtzblatt's (1998) method *Work redesign* can be used as a way to improve the users' work practice; this is a step where the designer should invent an improved work flow for the user, based on the users' issues. In "Work redesign" it is useful to utilize storyboards or scenarios to define how people will work in the new system and to ensure that all aspects of work are captured in the work models.

Scenarios or storyboards are often more easily understood than process models or specifications, the latter offers no touchstones to the user's experience and often requires introduction to a new language. Scenarios are just expedients for articulating which issues really matters to the user. It is not realistic to expect that users will describe how the system shall be *structured*, or function, just by the use of a scenario. To capture that level of feedback one must couple events to the scenarios. (Beyer & Holtzblatt 1998, p 369-370)

4.2.3 Produce design solutions

When the requirements are specified it is time to produce design solutions. Multiple designs are to be preferred since it leads to more knowledge and finally gives a better design. The activity should include to:

- Evolve the principal features of the design solution with multi-disciplinary input
- Concretise the design solution by using simulations, models etc.
- Present the design solutions to users and let them perform simulated tasks
- Iterate the process until the design objectives are fulfilled
  (BS EN ISO 13407:1999 p 8)

Designing IT-systems – paper prototypes and mock-ups

Löwgren and Stolterman (2004) argue that the complex design process is in constant need of *externalising* the design thoughts, in other word to represent the design in different ways. Sketches, models or prototypes can be seen as the first external representations of the ideas that the researcher first thought of concerning the design. It is furthermore reasoned that sketching has three different functions: (1) To form ideas (2) To communicate with oneself (3) To communicate with others. Sketching ideas is the core activity of design work, it is the most important way to present ideas, formulate and estimate the value of different ideas, and to convey a vision.

The aim of a new design is to transform an existing reality into something more desirable, something that does not exist today. It is therefore impossible to truly estimate a design solution before it comes into use. (Löwgren & Stolterman 2004, p 43) Löwgren and Stolterman (2004) argues that design is an *unsure activity* – it means dealing with the unknown and to design something that does not yet exist, an *ethical activity* – the design choices will affect peoples' life and handling space, an *aesthetic activity* – every new design adds something new to our general impression, a *political*

and ideological activity – the design influence the way people relate to others, the society and to the nature (the designer can use its political agenda when designing). (Löwgren & Stolterman 2004, p 6)

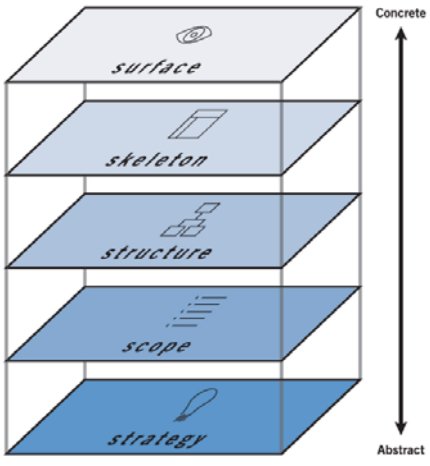
Terry Winograd, professor of computer science at Stanford University, is using the following words to describe the designer's work:

> ”I think what the designer is trying to do is envision things for users that the users can't yet envision. The hard part is not fixing little problems, but designing things that are a bit innovative and that work.” (Preece et al 2002, p 71)

Design at different levels

The design process is often divided into two parts; producing divergent and convergent design solutions. Divergent solutions is the starting point in any design matter, it is the phase when the designer works broad – studying different alternatives, opportunities and ideas. Working in parallel with divergent solutions makes it possible to explore creative ideas, and on the other hand it prevents falling in love with an idea. It is easier to “kill you darling” when there are other possible solutions. The best solution can only be found when the design space has been thoroughly examined. (Löwgren & Stolterman 2004, p 38-40) As Ernest Hemingway, the Nobel Prize winner of literature in 1954, once said “The first draft of anything is shit”. (Wikiquote 2008) The design process will finally end in convergent work – which means narrowing the ideas towards one solution, or to a synthesis of different ideas. (Löwgren & Stolterman 2004, p 40)

Preece et al (2002) mean that prototyping can be broken up in two sub-activities: conceptual design and physical design. Conceptual design describes what the conceptual model of the product will do, behave and look like. Whereas the physical design determines the details of the product, such as colours, sounds, menu design, icon design etc. (Preece et al 2002, p 169)



Garret (2001) describes in his book “The elements of user experience” how to develop homepages to ensure that no aspect of the user's experience happens without your conscious. Even though the theories are based on developing for the Web, many points can also be useful in ordinary system development. Garret (2001) argues that the *set of decisions* made during development will result on the final experience. Decisions can be made at different levels, and they build upon each other. The design process can be seen as decisions at fives planes: strategy, scope, structure, skeleton and surface. On each plane the issues become a little less abstract and a little more concrete. The first plane decides the *strategy* of the object, what the researcher and the user wants to get out of the site/object. It is followed by the *scope* that tells which features and functions should be included. The *structure* tells how and why the user goes to the page. The *skeleton* is a concrete expression of the structure; it should further be designed to optimize the arrangement of the included elements for maximum effect and efficiency. The top plane decides the *surface*; how the object's images and text should be designed in detail.

Each plane is dependent on the planes below. Decisions on the strategy plane will have a "ripple effect" all the way up the chain. But dependencies run in both directions, decisions made on upper planes may force a re-evaluation of decisions on lower planes. (Garret 2001, p 22-25)

User interface can be based on windows or workspaces

An approach when designing IT-systems is to use the *workspace metaphor*. The workspace metaphor can be viewed as an alternative to "multiple windows". Every workspace is designed to fulfil the requirements of a certain actor, and has consequently a specific authority level. Depending of the actor, the workspace admits or denies access to information. A user can play the role of one or more actors.

Lif et al (2001) mean that it is easier for the user, advanced as well as novice, to become oriented in the information space if all required information and all operations are gathered in one workspace.

Design heuristics according to the workspace approach:

1. *Simultaneous presentation of information*; a skilled user can easily overview a large set of familiar data
2. Support *pattern recognition*; decoding of frequently occurring, meaningful patterns can be performed on an automatic cognitive level without interfering with processes performed on a conscious level.
3. The workspace *contents* should have an obvious character that immediately reveals the kind of tasks that can be performed there.
   (Lif et al 2001, p 115)

4.2.4 Evaluate design against requirements

Evaluation is an essential step in human-centred design processes and should take place in all stages at the life cycle of the system. Evaluation is useful for:

- Providing feedback which can improve design
- Assessing whether user and organizational requirements have been achieved
- Monitoring long-term use of the system
  (BS EN ISO 13407:1999 p 10)

The final design solution will effect the user's work situation, hence it is important that the design is well-thought out and evaluated. To quote Löwgren and Stolterman:

> "Design of digital artefacts is by some meaning design of peoples lives". (Löwgren & Stolterman 2004, p 1)

The final step is hence to evaluate if the users' and organizations' objectives are fulfilled, and is valuable to get feedback about improvements. There are different kinds of evaluation methods, with different degrees of formality and user participation. It is the actual product that does decide the most suitable method, concerning economy and time limitations. (EN ISO 13407:1999 p 10)

The sooner problems are found in the system, the less it costs to fix them. It is therefore important to continuously test the product with users, using rough paper prototypes called *Mock-ups*. Paper prototyping is a quick method and it is neither hard nor time wasting to make changes in the mock-ups. Snyder mentions in the book *Paper prototyping* (2003) that polished-looking prototypes can encourage low-level feedback about the visual aspects of the design. It is easier to evaluate more basic paper

prototypes, since it is obvious that the final look yet is not specified in detail. A design solution that is still on the drawing board can more easily be questioned or even criticized. Beyer and Holtzblatt (1998) mean that even a blank box can give enough structure to discuss the prototype with users. (Beyer, Holtzblatt 1998, p 395) This leads to a better design solution in the end. (Snyder p 58) To quote Beyer and Holtzblatt: “A good prototype is clean but looks like it can be changed” (Beyer & Holtzblatt 1998, p 395).

The evaluation should stay grounded in real events. The researcher may either replay a real past event, or tell the user to use a past event in the prototype. (Beyer & Holtzblatt 1998, p 396)

5. Understand and specify the context of use

Chapter five aims to describe how I examined the context of use, and to present the results from this first activity in the iterative loop of ISO13407. The users of a future HI-object are described, as well as their fields or responsibility, their work tasks and context. The information in chapter 5.2 is the result of my observational interviews; no references are made to specific respondents.

5.1 Conducted contextual observations of six users

Before I conducted the first contextual inquiry I made a visit to the geriatric ward introducing myself and the study. This visit allowed me to familiarize with the general work flows and the organization, before my actual observations took place. During the first phase, contextual inquiry, I observed and interviewed staff who represented the various roles at the geriatric ward. Six members of staff were observed and interviewed, one senior physician, one physician, one nurse, one assistant nurse, one physiotherapist and one occupational therapist. These members of staff were chosen since they all represent an actor of the ward's care team.

The observations were carried out for approximately half a day each – I observed one actor individually when s/he performed the daily tasks. I switched between Blomberg et al's (2002) two roles observer-participant and participant-observer to get an overall picture of the work flow. The observational role gave me a broader perspective on events and the time to analyze it; simultaneously I got first-hand experience on the events when participating more actively in the user's tasks.

5.1.1 Methods for gathering information

Notes were made during the inquiries, but no tape or video recording. The cause was on the one hand that recording might have influenced the users, or the patient, and on the other hand due to the special characteristics of contextual inquiries. Since the observations were made in the field, *in situ*, it is difficult to capture significant interactions through the view of a video camera.

5.1.2 Framework and focus

When performing my observations I focused on the actor's *required information* when dealing with a patient's specific health issue. In other words, which kind of information the user needed to get proper situation awareness. Special focus were made on the following questions (based on Beyer & Holtzblatt's guidelines p 100)

- Are there any informal guides or information?
- Who/what supplies with the information needed to do the tasks? Who uses the information?
- How does the system support a health issue based work?
- In which social and cultural context is the work performed?
- Are there any metaphors that can be used to support the tasks?
- Notice if there are any tasks that fails, this may give good clues about the user's line of thought. Failures and hesitation indicates that the users understanding of the work conflicts with the tools he's using. If so, tell the user to think aloud to explain the situation.

5.2 Results from the observations – the geriatric ward's context and users

The ward's main concern is rehabilitation which implies that the patient's *total health condition* is interesting for the caregivers – one can then talk about the patient's "set of health issues", not a single specific health issue. The care teams' mission is therefore to classify and treat the patient's general health condition (the set of health issues).

5.2.1 Description of the users' context

The ward supplies institutional care for elderly patients – the ward can receive a maximum of 25 patients at the same time. Patients are attending the ward for rehabilitation – they are all registered by incoming referrals, from other wards. Only patients at the age of 65 years or older are admitted to the ward, since the ward is specialized on care and diseases of elderly people. Typical characteristics of these older people are multi diseases and a heavy medical record.

5.2.2 Description of the care givers – users of a future HI-object

The ward is divided into two parts, which in turn have one "care team" each. The teams are formed with specialized care givers that care for elderly patients in different ways. Each team consists of a physician, nurse, nursing auxiliary, occupational therapist, and a physiotherapist. Dieticians and welfare officers are called when needed, but these professions are normally not present at the ward at a daily basis.

A conference is held once a week to maintain an overall understanding of the patients' health conditions. All involved care givers are represented, sharing their conception about the health issues. Whenever all care givers can agree that the patient no longer is in need of additional medical treatment, contact is made with the local authorities for a common care planning. This is frequently occurring, and happens approximately once a week. Besides contact with the local authorities, the ward is in continuous contact with the patient's relatives, previous care givers as well as other clinical departments at the hospital.

All of the care givers, except the assistant nurse, are by law obliged to keep journal of the care given. And consequently, it is not uncommon that the same information is written multiple times.

5.2.3 The users require a common informational foundation

The care givers are focused on the patient's overall set of health issues, and the informational foundation shall in optimum be shared by all care givers. Naturally enough there must also be specialized information for specific professions, even though the overall picture is the same for all professions. To supply a reasonable informational foundation, the care givers must maintain a good level of communication between one another.

5.3 Results from each observation

The care givers have individual tasks and assignments, but the overall goal with rehabilitation is shared between all care givers. The rehabilitation conference can be seen as a symbol of the ward's collaboration, or at least aim of collaboration. Sharing information is fundamental for cooperation. Below is a presentation of the users, their tasks and requirements.

5.3.1 Physician

The physician's role at the ward is at one hand to judge incoming referrals concerning a possible new patient, and at the other hand to investigate and treat for the patient's health issue.

In both these tasks, the physician needs to get a quick overview of the patient and the status of the actual health issue/s that the physician is responsible to treat. S/he can get good situation awareness just by looking at the relevant health issues, the medication administration list[3], the list of medications[4] and by getting a status update from the responsible nurse. In addition, it is also valuable to know if there are any new incoming referrals or lab answers.

When judging an incoming referral or diagnosing a new patient, it is also important to understand the patient's health record and the patient's social background (e.g. if the patient is a widow/er, the living situation, if the patient has previously visited the geriatric ward or another geriatric ward earlier etc). This information is also interesting to the other care givers when treating and visiting the patient. It also gives the patient a sense of confidence and trust, if s/he knows that the care giver is conscious about hers/his progressive life situation as well as health background.

To understand the patient's anamnesis[5] the physician reads the discharge letters from previous wards, especially the discharge letter from the last care giver. The physician reads in general mostly the physician notes, but the wards total notes are also read from time to time (especially when preparing the weekly conferences).

5.3.2 Nurse

The nurse is acting as the hub in the division, s/he is the person who should have all the base information about the patient and his/hers health issue/s. To get awareness about the present situation, the nurse needs the same information as the physician – and also more detailed information about the planned and daily activities.

The nurse is further in need of detailed information concerning the patient's social status, such as contact information to relatives, the general physician and nurse etc. In other words, the nurse needs information that may not always be related to the actual health issue.

5.3.3 Assistant nurse

The assistant nurse deals with the daily nursing; s/he is the care giver who has the most direct contact with the patient. S/he works on basis of the information given orally by the nurse, physiotherapist and occupational therapist. To get a better understanding of the patient's health issues, s/he also looks at the medical record – with special attention to the care plan, observation report, notes by the physician and referrals and lab answers. Since the assistant nurse is seeing the patient on a daily basis it is important to understand his/hers situation, including the reason of registration and the patients process through the care chain.

The assistant nurse is working mainly from the patient list – where s/he can write each patient's health issues and present health condition. It would be good if the health

[3] Cosmic's "Medical Administration List" shows which prescribed medicals the patient has during the actual care period

[4] Cosmic's " List of Medications" shows all of the patients medications, even those that might be paused because of the hospital treatment

[5] The medical history of a patient

issues, reason of registration and present health condition would be pre-printed on a list that the assistant nurse could bring each day.

5.3.4 Physiotherapist

The physiotherapist is the care giver that focuses on training the patient's strength, movement abilities and balance. It is the physiotherapist's responsibility to continuously inform the other care givers about the present movement condition of the patient.

When planning a patient's training, and putting up goals, the physiotherapist must understand the living situation, if there has been any previous physiotherapy, and if the patient has got any restrictions matters to his/hers movement pattern (this may for example be the case after a surgical operation). When the physiotherapist has got a clear picture over the patient's status, s/he puts up realistic goals with the physiotherapy. These goals are henceforth extremely important, and it is needed that all connected care givers are informed of these outlines. The physiotherapist can see a problem in today's work processes, it is generally quite usual that the care givers are not enough informed about the present health condition – this may cause a negative effect with the planned goals. It is naturally of great importance to follow up the goals, to see if they were accomplished or not.

The interviewed physiotherapist reported that the physician is not always updated about the actual training situation, since the physician primarily read his/hers own profession's notes. She inquiries a better communication between the different professions, it is important to constantly highlight the progress of the patient's health condition.

5.3.5 Occupational therapist

The occupational therapist collaborates mostly with the wards physiotherapist, and the assistant nurse. S/he is the care giver who gives most attention to the patients' living situation – the goal is to help the patients achieve a fulfilled and satisfied state in life, under their own conditions.

Training may thus include activities like cooking or personal care; the forms of training depend on which goals the occupational therapist has set up, in consultation with other staff in the care team. To understand the situation, the occupational therapist needs detailed information about the living situation, contact information to those who are concerned in nursing the patient, as well as continuous information of how the patient is feeling and developing at the ward.

The occupational therapists daily work proceeds from the patient's specific goals. Since the list of goals is so important in her work, the occupational therapist reports that she would appreciate a better component to facilitate feedback and progressive work.

6. Specify the user and organizational requirements

Chapter six corresponds to the second activity in the ISO-standard. The chapter declares how the data analysis was performed, and what kind of requirements the analysis ended in.

6.1 The observational data were analysed and consolidated

When all data was obtained from the observation interviews I used methods to classify the data and to clarify in which processes a HI-object would be useful. The users' informational requirements were primarily understood by Beyer & Holtzblatt's method Affinity Diagram (1998) and by Ottersten & Balic's method Effect Map (2007). The requirements, that would support an increased Situation Awareness, differ between users and user groups but they are also shared between several user groups.

The application of Affinity Diagram and the outcome

The affinity diagrams were rather used for listing the different categories of data and to recognize process patterns in the collected data, than to discuss the work flow with the users at this time. Producing the affinity diagrams were hence made without interaction with the users, this was also the case due to the thesis's shortness of time. The method was performed using post-its and ended eventually in a picture of the processes where a HI-object could be usable.

The identified processes were:

- Process of planning (judging and planning the future of the incoming referrals, planning training and medication at the ward and planning the discharge and future care)
- The process of registration
- The process of diagnose
- The process of medication
- The process of documenting the health condition refinement

The affinity diagram also sorted out the characteristics of different work tasks at the ward. Hence, which tasks those are most frequent during the registration of a new patient, during the rehabilitation and during the discharge and planning for the future (common care planning). All of these tasks would not benefit a HI-object, but the first attempt to make an affinity diagram was nevertheless useful for understanding the context and work flows at the ward.

The application of Effect Map and the resulting requirements

When the work processes were understood I made an attempt to formulate an effect map; a map including the HI-object's aim, target groups, usage goals and actions. To make most of the effect map I adjusted the method in several ways to my study. Since Ottersten and Balic's method is mainly developed as a methodology for project management, I adjusted the method to better fit into the context of my study. My study's aim is to break down a work process and prioritizing special aspects of that process, rather than project management. An individual effect map was therefore applied to every single process that was previously identified through the affinity diagram. When sketching my effect map I proceeded from the affinity diagram, and

identified the processes where an HI-object could improve the care giver's situation awareness.

The overall aim with introducing the HI-object is to *simplify the care giver's situation awareness of a patient's actual health issue, or health issue group, during the rehabilitation process*. The effect map resulted in a total requirement specification to fulfil this overall aim with the HI-object. The requirements correspond to the design aspects that must be implemented to support the aim. It is therefore utterly important that the effect map has a correct content since it functions as the foundation for the design

The ward's processes and activities can be described with the following flow sheet, see figure 3, which is chronologically ordered. The activities' aim can be summarized as the *total process of rehabilitation* – which in turn is divided into three larger parts with a few sub-processes.

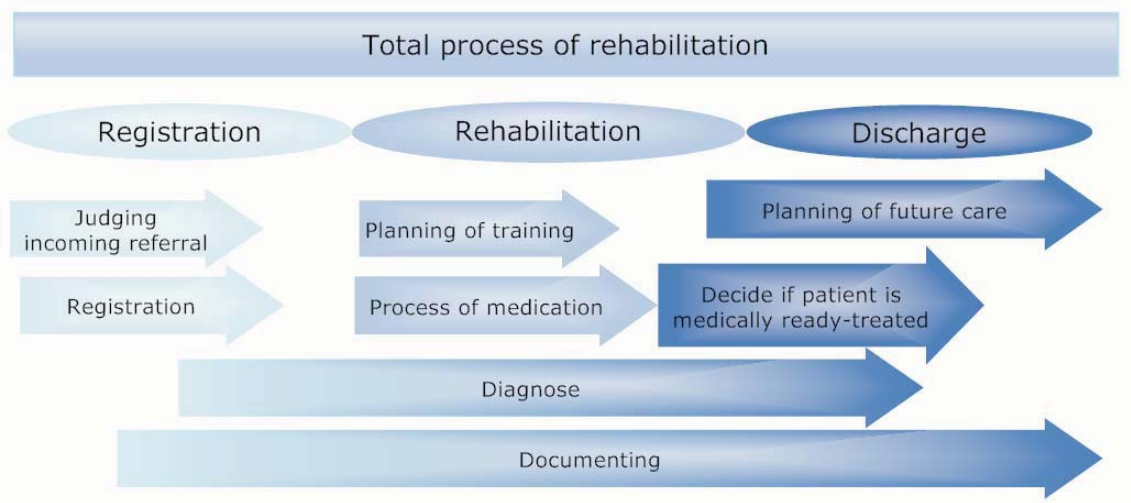
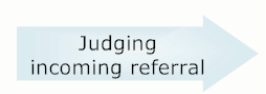


Figure 3: Schematic of the identified processes. Each process has its own effect map.

The eight sub-processes (arrows in figure 3) all have their own aim, for example facilitate the judging of incoming referrals which has underlying target groups, usage goals and actions. All of these underlying aims support the overall aim. The effect map is in total very extensive, and consequently I will only show a cutting in this report. Let us complete the example given above:



Aim: Facilitate the judging of incoming referrals
Target group: Senior physician when reading an incoming referral
Usage goal 1: Senior physician needs to understand the actual health state
Actions:

- ✓ Show an overview of previous health issues
- ✓ Show referrals and the latest note from physician
- ✓ Make it possible to understand the actual health condition (ADL-capacity, appliances etc)

Usage goal 2: Senior physician needs to understand the patient's actual care requirement and the social background
Actions:

✓ Show anamnesis
✓ Show the patient's social status and address
✓ Make it possible to see whether the patient has visited a geriatric ward previously and where if so

List of requirements

To sum up the results of the effect map the following actions need to be implemented if the desired effects of introducing a health issue based overview in Cosmic shall be met, see figure 4 below.

Show an overview of previous health issues
Show the patient's reason for registration
Show anamnesis
Make it possible to understand the actual health condition
Show new observations, if any
Show actual health issue, with focus on the latest note by physician
Make it possible to see whether the patient has visited a geriatric ward previously, and where
Show the patient's social status and address
Show the living situation
Show the name and number to external contacts (relatives, district physician, district nurse etc.)
Show the patients temperature, blood pressure, nutrition values etc.
Make it possible to see if the patient has any restrictions in his/hers movement pattern (for example after an operation)
Show actual movement pattern
Make it possible to compare the goals with the actual health condition
Show programme of care or clinical guidelines to the actual health issue
Show referrals and the latest note from physician
Show latest note by occupational therapist
Show latest note by physiotherapist
Show the list of actual drugs
Show the ordered labs and tests
Show new lab- and test results
Show the patient's previous drugs
Show previous lab results and referrals

Figure 4: List of identified actions in the effect map. The list can be read as a specification of requirements.

Scenarios to verify the effect map (work redesign)

To secure that the collected data truly ends up in the processes described in the affinity diagram and effect map, the method called *scenarios* were used to approve the analysis of work redesign. In combination with producing the effect map I made two visits to the ward where I met end users to secure the identified processes.

I met the same kind of actors as during the initial observations. To render some discussion, and to get hold of different views, I arranged two workshops which included different professions. The workshops were composed with professions with moderately similar characteristics (physiotherapist together with an occupational therapist and a

physician together with a nurse) – to render a valuable discussion at a common level. The workshops lasted for approximately one and a half hour each, and discussed several scenarios to each profession.

The scenarios described a future way of workflow (connected to the identified processes in the effect map), with future prospects including the health issue object. The health issue object was described as a way to facilitate the user's needs to understand a patient's health record easily.

The scenarios were constructed as a short narrative story about the profession's activities at the ward. The story also included how a future HI-object could help the user in her/his daily work. The actors got the chance to see how the HI-object would function to another group of users than themselves, which made it possible to discuss similarities and diversities between the users.

The workshops primarily resulted in an approval of my effect maps, and some minor changes in the requirements. It is also of importance to tell that the affinity diagram, effect map and scenarios were made in an iterative manner, and improved from loop till loop.

7. Produce design solutions

The aim of chapter seven is to make clear how the prototypes were produced, and finally introduce the prototype that was evaluated with the users at Uppsala University Hospital. It answers to the third activity in the user-centred design process declared in chapter four. Several internal iterations were made in this step, design solutions were continuously evaluated against the requirements and shortly afterwards revised.

Paper prototypes were made continuously throughout the thesis project, based on the, by time, increasingly developed requirement specification. As mentioned earlier, the actions defined in the effect map were watchfully implemented and analysed in the design solution. The prototypes were made with a rough look, where some focus areas or components were just outlined as a blank box (since these components were not graphically designed in detail yet). As Beyer and Holtzblatt said:

> "Even a blank box can give enough structure to discuss the prototype with users" (Beyer & Holtzblatt 1998, p 395)

Low-fidelity prototypes were made partly by hand (rough sketches) and partly by the prototyping tool Visio 2003 (in the later phases of design). Appendix 3 shows an example of the methods used when prototyping by hand.

7.1 The process of prototyping – prototyping at different levels

The process of prototyping was divided into several phases/planes, according to Garret's (2001) theories of user experience. The first two planes, scope and strategy, are described in chapter 2.1.2 as the aim with the HI-overview and its framework. The following design process focuses rather on the remaining planes in Garret's theory. Since the aim of the thesis is to develop a conceptual design draft I have mainly focused on the structure and skeleton phases – two steps that choose the design in many structural ways, as well as the content of the design.

The process of prototyping involved rating and judging different design alternatives against each other, and to make active choices concerning which aspects should be included in the design concept. One of the different design alternatives can be seen in appendix 1, including description.

7.1.1 The structure

One of first steps in the design process was to sort out a reasonable structure of the components and the informational flows; it is an important step since the structure defines future design steps in some points. It is furthermore the part of the process that decides which components shall be included in the model.

The structure was defined rather early in the design process, simultaneously with the tuning of scenarios with users. It was decided that the health issue object should be composed of two different overviews – one that would function as an anamnesis (including the patient's overall health care record) and another overview that would be used in the daily hospital treatment regarding a specific health issue or set of health issues. Which information, or components, that would be interesting in the object were stated as actions in the effect map, see figure 4 at page 28.

7.1.2 The skeleton

When the structure was fairly determined, I went on to design the skeleton. The skeleton gives a sketchy view of the prototype, and tells where the included components should be placed in order to reach a satisfying result.

The idea was to produce a view that would have a common skeleton to all users, but possibly with some internal diversity due to the user's access rights and informational needs. The advantage of a common skeleton is the users' possibility to discuss a patient from the same frame of reference.

Thoughts and motive behind the final skeleton

The graphical component (representing the health issues) were planned to play a central role in the overview. Hence, it was placed at a place that naturally gets focus of attention; the top left-hand corner.

The calendar, including the health issue based activities, were placed right near by the graphical component. The reason for this was the natural connection between a health issue and its activities.

The centre of the view contains the medical record notes. This component is used in almost all situations and should thereby be easy to read. The medical record notes shall also be possible to read in combination with other forms of information, which implies that a central placing is preferable.

The left side of the overview, under the calendar, contains either the social status or the dynamic component – depending on which overview one looks at.

7.1.3 The surface

The design concept is further detailed by the graphical surface; the choices made concerning the surface are briefly described as follows.

The different components were separated with the use of boxes/squares; it makes the overview calmer than if all information would be united by a single common frame. A further design characteristic is the lack of unnecessary scroll boxes. The aim of the overview is to give a quick and transparent awareness of the situation, and for this quick comprehension the user shall not be obliged to search for information (as scrolling or looking at different modules). The opportunity to scroll for further information may be given, but the directly visible information shall be the most actual information.

Some components were designed in several steps and thereby in more detail than others. This would unquestionable be done concerning all components seeing that the thesis's would not have a limited period of time.

This thesis has not taken into account any limitations concerning the screen's resolution[6], since the focus of the design was not primarily the graphical details in the surface. It is hence not certain that the prototypes would fit the actual format of Cosmic.

7.2 The final prototype

The prototype which was evaluated with the users was composed of two different overviews, separated as two different tabs. The following chapter describes the design of the two overviews, and the design of a pop-up window that relates to the requirements concerning clinical guidelines and programme of care. The following two pages show the different overviews, before describing them in detail. The chapter ends with a description of the implementation of clinical guidelines.

[6] Cambio Healthcare Systems AB recommends their customers to use a resolution of 1024x768.

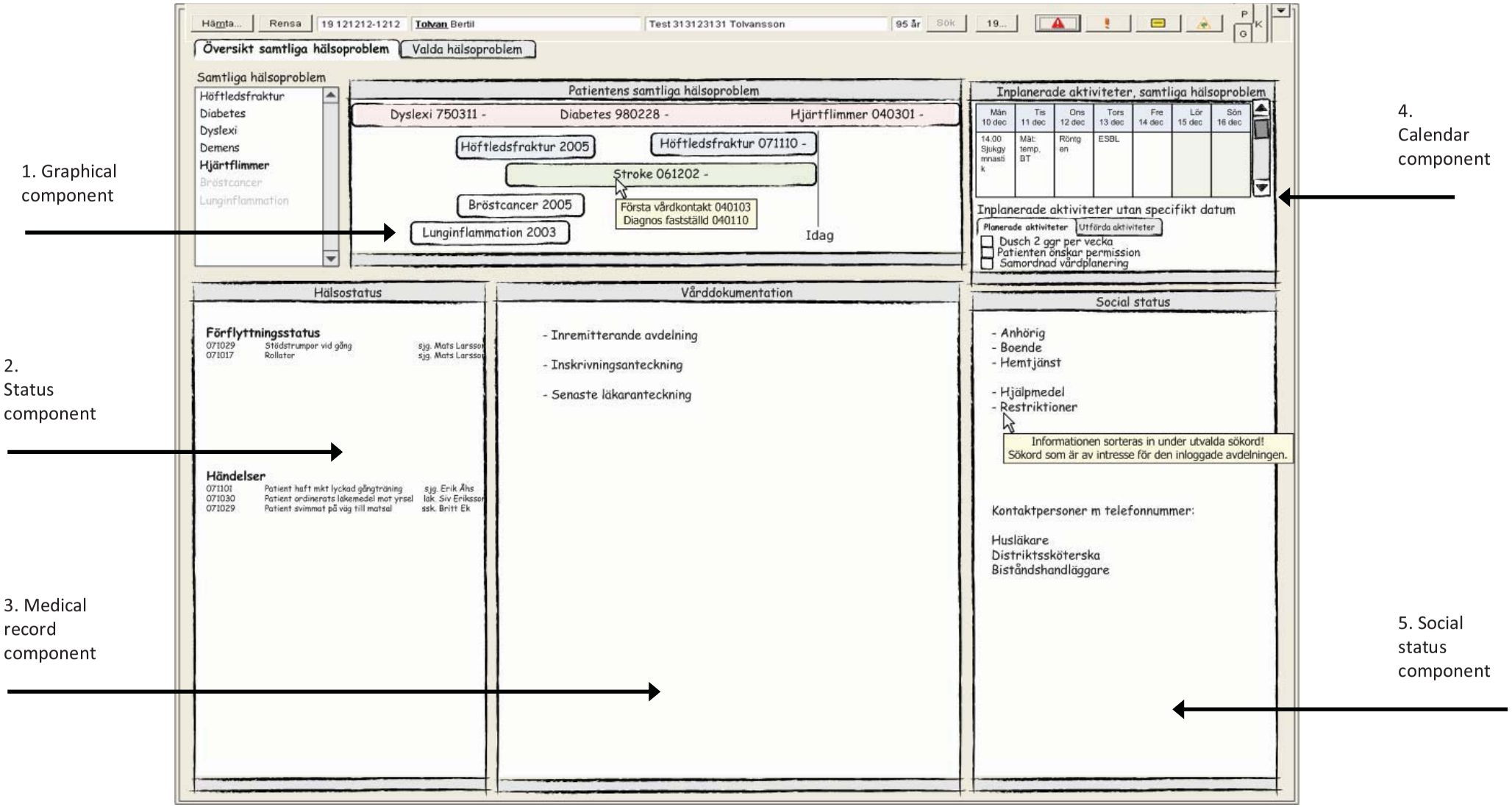


Figure 5: The prototype "Overview of all health issues"

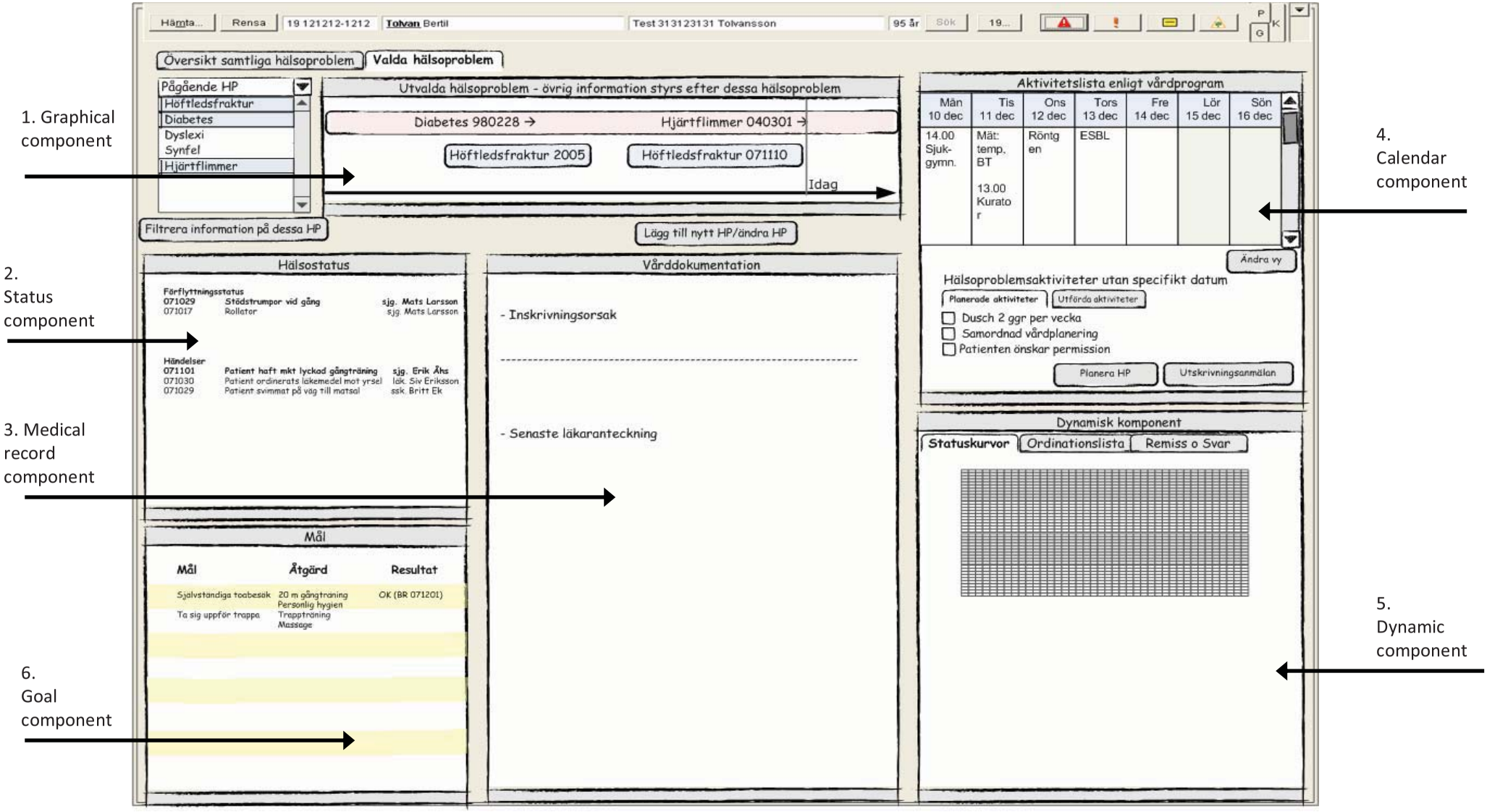


Figure 6: The prototype "Overview of actual health issues"

7.2.1 Description of the prototype “Overview of all health issues“

The first tab “overview of all health issues” can be seen in detail in figure 5. The purpose of the overview is to render the possibility to quickly understand the background of the patient, and possibly the cause of the actual health care. It shall further give personal information about the patient, as well as an update of the actual health condition (which might depend on something else than the actual health issue). The overview shall mainly provide an informational foundation to understand the patient (situation awareness), rather than functioning as a work space. The overview consists of different components, which are described briefly below.

1. Graphical component
The graphical component consists both of a text list, and of a graphical overview of all health issues. It should both be possible to *read* the health issues in an ordinary list, and also to *perceive* them more visually. The aim of the graphical component is to envision the actual and previous health issues, and *to render the possibility to put the health issues in proportion to each other*. My hypothesis is that a view that shows all health issues in a time scale may provide a better understanding of the health issues and their possible connections.

2. Status component
This component is supposed to give an awareness of the actual health situation. This information was previously posted orally by e.g. a nurse, or written in the “Observation report”. By placing this information in an updated overview, it will be more easily obtained. If the information, or non-information, is always present the care giver would without any effort see if any news has occurred. The care giver would not have to spend unnecessary time to investigate at a specific location in the system, nor to unnecessarily disturb the responsible nurse.

3. Medical record component
The medical record is naturally vital in any care situation, it is the component where all findings shall be reported and evaluated. The idea of placing this component in the overview is the possibility to compare medical notes with, for instance, the latest health condition or the list of all health issues.

4. Calendar component
When planning the treatment of a specific health issue, it is rather common to plan specific activities to investigate or treat the health issue. It may for example be a planned x-ray to investigate a possible fracture or daily lab analysis to follow up an infection. The patients are often staying at the ward for approximately two weeks, whereas a weekly calendar would offer an explicit overview of the planned schedule.

5. Social status component
The social status of the geriatric ward’s patients is important for the understanding of the patient, and for the care planning. The patient’s living situation (widow/er, home-help service, apartment at second floor without elevator etc.) steers the rehabilitation process. This component may also include contact information to the district medical officer and other engaged persons.

7.2.2 Description of the prototype "Overview of actual health issue/set of health issues"

When treating a patient due to a health issue, or set of health issues, the user can look at the tab named "overview of actual HI/SHI" see figure 6. This overview aims to give profound information concerning a chosen health issue. The basic idea is that information concerning the health issue shall be tagged, and afterwards be visible to anyone (with access authorities) who shall treat the specific health issue.

1. Graphical component
The graphical component is similar to the same component described previously. The only difference is that the list only includes those health issues that are still in progress, more or less active. The actual health issues, those that the ward are treating during the actual care episode, are on one hand marked in the list and on the other visible in the graphical view.

The graphical component was designed in several versions, see appendix 2. The enclosed versions are further on called "enriched graphical component"; they have the same structure as the graphical component but include in addition some milestones and activities of the health issue. The enriched graphical component can tell where the patient has been treated, and certain activities that have been done or are planned to be done in the future. The idea was hence to replace the calendar with graphical symbols visible in the time scale. There would be opportunities to choose which activities that would be shown.

2. Status component
As previously described this component shall supply news about the patient's actual health condition.

3. Medical record component
The medical record shall be filtered by the health issues that are chosen in the graphical component, and further filtered by the user's access rights. It is primarily thought that this component shall support the user with information from the medical record, but it may also function as a work space where it is possible to write new notes. The box would then be expandable to function as a good documenting area, but still be surrounded by information that is helpful when writing a note (such as lab answers or a referral).

4. Calendar component
The calendar would be filtered by the health issues that were chosen in the graphical view. The care giver would get the chance to take part of the planned activities for the specific health issues, and would hence get an overall picture of the total treatment.

5. Dynamic component
This component has the purpose of offering profession specific information, in other words; a component that has a dynamic appearance dependent on which user is logged in to the system. An assistant nurse would for example get information concerning the nursing plan, while the physician would get noted if there are any new test results or referrals, see the list of medications and a graph that shows the changes in temperature, blood pressure or nutrition values. It would be indicated if there were any new test results or extreme values in the graph.

6. Goal component
The purpose of the goal component is to display the planned *goals with the treatment*. The component shows the different goals, their proceedings and final results. The hypothesis is that the ward's expressed team work would benefit an overview where the common goals are visible and a constant reminder of the teamwork.

7.2.3 Implementation of clinical guidelines

In addition to the overview I made further sketches concerning HI-related work tasks. Apart from the overviews, which would hopefully provide a safe foundation to the care givers when giving care, I also wanted to examine if there can be other, supplementary, solutions to potentially achieve a more quality based healthcare. An idea was hence to provide the care giver with clinical guidelines, or programme of care, to a specific health issue. It could be useful when planning the treatment of a patient.

Clinical guidelines concerning a specific health issue is today given on a national basis, and there also exists care programmes which are linked to a specific region or hospital. (Nordgren 2007) The implementation of clinical guidelines and programme of care can be seen as requirements in figure 4. Since this type of information is only needed in some specific cases, I made the choice to make it visible only when the care giver actively wants to see it. This component is hence not included in the basic overview, but it shall be easy to reach through a button or a tab in the overview.

The prototype, which can be seen in figure 7 on the following page, shall give the user an opportunity to see recommendations of treatment to a specific health issue in combination with the total care plan. The overall thought is that it should be easy to see appropriate, or frequently occurring, activities connected to the actual health issue. It shall furthermore be straightforward to paste the chosen activities into the care plan. These activities should subsequently be automatically pasted into the calendar component.

Easily accessible guidelines would partly help the care giver during decision-making, and would partly play an important role in healthcare research when following up certain treatments or health issues.

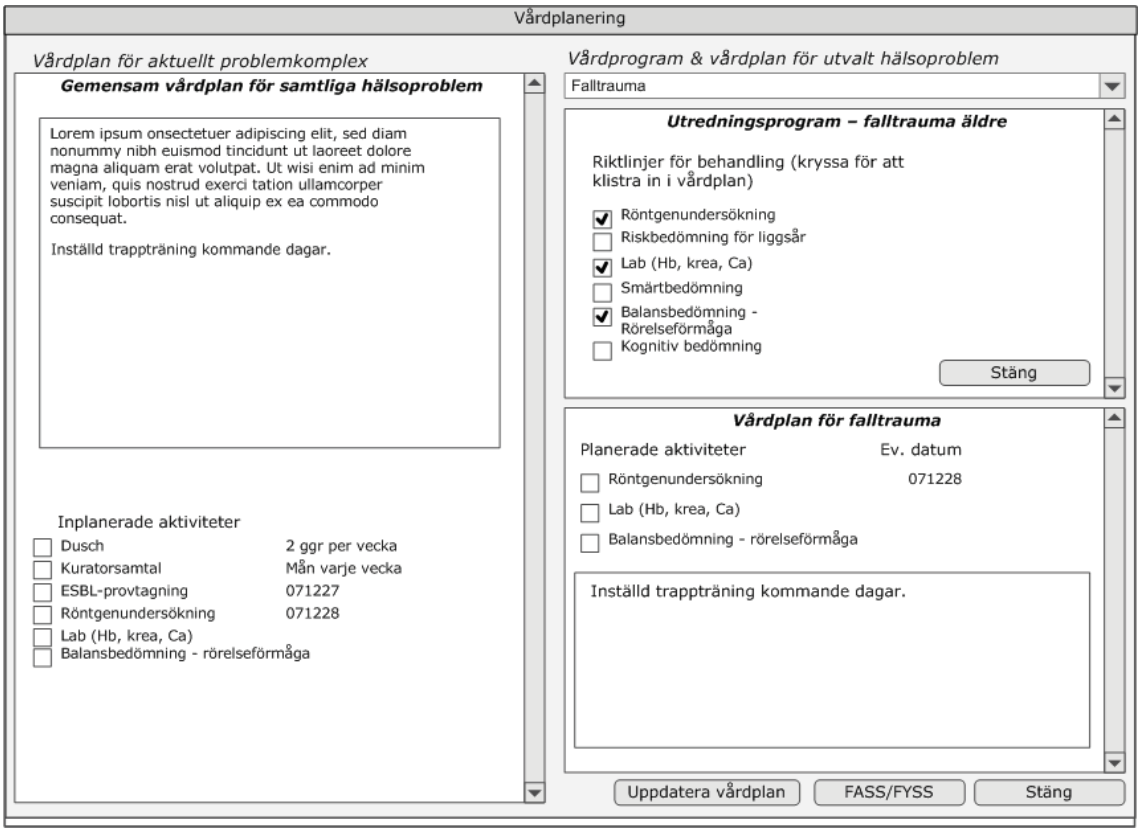


Figure 7: Prototype of a pop-up window which includes the care plan and clinical guidelines.

8. Evaluate design against requirements

The following chapter describes how the forth step in ISO 13407 was performed in my study. The result of the evaluation is presented under several subheadings, corresponding to each component of the prototypes. Finally there is also a brief subheading that presents the thoughts of the overall prototype.

8.1 Evaluation with nine end users

The mentioned low-fidelity paper prototypes were continuously evaluated against the identified specification of requirements and by the end-users at the geriatric ward. Approximately half of the evaluations were made with users whom I met during my former observation interviews, and the rest was entirely new users. The selection of users was based on Beyer and Holtzblatt's recommendations, which declare that a mix of users is to be preferred. (Beyer & Holtzblatt 1998, p 401) The same kinds of actors (representatives of the care team) were interviewed in both the former observation interviews and in the latter evaluation interviews.

The users got the opportunity to try different prototypes; where the overall structure and skeleton were similar but the prototypes had somewhat different surface and contents.

8.1.1 Scenarios in the evaluation

The evaluation should, according to Beyer and Holtzblatt (1998), stay grounded in real events. The users were hence told to imagine how the prototype would have helped or influenced them in a past event. I also told the user to describe what they thought that the prototype would do. And further, to tell in which situations the object would be useful and why.

8.2 Results from the evaluation

The target groups evaluated the prototypes in private, except for one initial meeting when a physician and a nurse evaluated a prototype in discussion with each other. Private evaluations have been preferred since that made it possible to deeply enter the requirements of a specific profession, and how that profession would use the prototype.

The prototype was evaluated by nine users: four physicians, two nurses, one assistant nurse, one physiotherapist and one occupational therapist. This chapter presents some of the opinions made by these user groups.

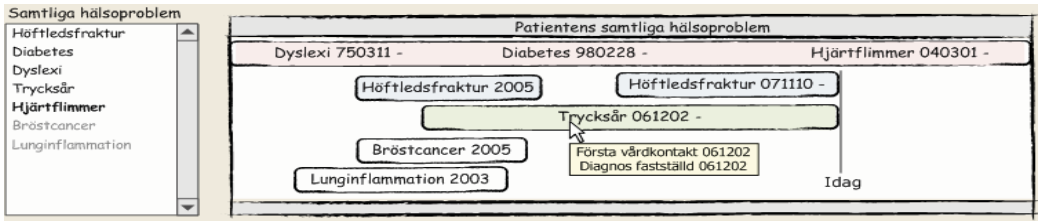
The evaluation session

The users evaluated a prototype consisting of two pages — the first page functions as an anamnesis and the other shows detailed information about the actual health issue/s (figure 5 and 6). The second page, figure 6, was shown in different versions; all versions had a similar framework but they differed with some internal changes (see the different versions in appendix 1). The small changes were made to stimulate the user to think outside the box — it is easier to form an opinion of the design if one can judge it towards something else.

The pages were designed identical to each group of users, in this manner the results can more easily be compared on a scientifically basis.

The users were asked if the designed components were appropriate, and if anything were missing or supernumerary to give the care giver *situation awareness*. They were also told to describe how they would use the pages in a general day at work, preferably in a realistic scenario. Prototypes of the implementation of clinical guidelines, figure 7, were also evaluated.

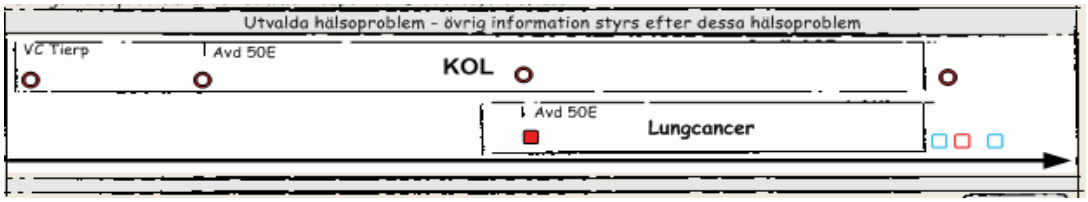
Graphical component



All users highly appreciated the graphical overview of previous and present health issues — it gave them an important overview of the patients' history. One of the users also pointed out that she was more of a "picture person" ("imager" according to Procter & Van Zandt (1994), see chapter 3.3) than a "text person" – and such a graphical view would unquestionably offer her a faster understanding of the patient's actual situation than a mass of textual information would. This point of view was spread over all categories of users, but declared in somewhat different words.

A few users considered that the graphical component could compensate a lot of information that is otherwise read in text; for example the "reason for registration" – the health issue that was the reason for registration could for example be highlighted in some sort of way in the graphical view.

Enriched graphical view (including activities and time spans at different wards)



An enriched graphical view seems clearly valuable for some user groups; the assistant nurse and the nurse. The physicians emphasise that a detailed view (including special activities, treatments and time spans at different divisions) would be helpful if, and only if, the view would be clickable and give detailed information (from the medical record) such as *notes* from the activity or *discharge letter* from the other division.

One physician meant that a clear, graphical, course of events related to the health issue would help him to understand *why* a special diagnosis was made. The course of events, or the missing of events, can explain the actual state of the health issue.

The physiotherapist meant that an enriched graphical view could be interesting regarding *some* health issues — but not all of them. It may for example be interesting to see if the patient has been registered, or not, at a rheumatic division concerning his/hers health issue. Other divisions' physiotherapy may be interesting when planning the patient's actual training. The physiotherapist says that this enriched information may be interesting in some specific situations, but not daily.

The nurse and assistant nurse gave another point of view concerning the enriched graphical view. It is not uncommon that the patient (or the patient's relatives) wonders where he/she has been placed, and under which time spans. An enriched graphical view could supply these informational needs. It is furthermore not abnormal that the patient has lost some personal belongings during the care period — the assistant nurse could

thereby be helped by an enriched graphical view to see where the patient has been placed earlier, and where the belongings may possibly be left.

An enriched graphical view seems though appropriate in several specific situations, which implies that this function should be easy to reach — but not constantly visible.

Status component

The idea of the status component was to show the actual status of the patient, related to the present health issue. News concerning the "move capacity" and "special events" was given as examples of actual status. Many users saw similarities to the "Observation Report" which the nurse uses today for writing news. That component is read every day by all categories of users, when starting a new shift at the ward. It gives a good picture over the actual status.

One physician meant that the status component is important primary during the morning round. An idea is to show this component only during those assignments, and to hide it during the rest of the day. This would function as different *workspaces* depending on the care giver's actual assignment.

One user, a physiotherapist, meant that Cosmic's format of the "Observation Report" is out-of-date (it has a different layout than the rest of the medical record), and she could not understand why those notes could not be written as the common "daily notes". A different kind of format (than the commonly used notes in the medical record) complicates the information retrieval, according to her. She indicates that shifting between different layouts can cause unnecessary high cognitive workload.

A design solution, using common daily notes in the medical record, would be to show these "status notes" automatically when a care giver logs in to the system for the first time at the shift (or give the opportunity to filter the information). This information is often just needed in the start of the shift, and during discussions such as rounds or conferences.

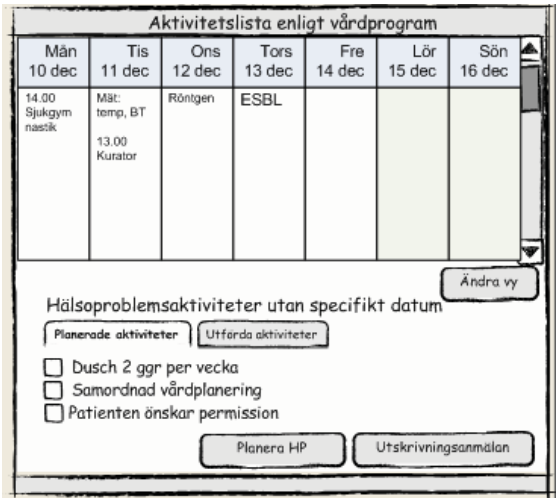
Medical record component

Several users expected the medical record to be possible to filter, as it works today. The physician was for example mainly interested in previous physician notes. The overall thought with the HI-object is though to sort information per health issue, so the basic structure of the medical record shall facilitate *all* information concerning the chosen health issue.

Some users were worried that the information would be difficult to obtain, dependant on the relatively small component. It shall hence be emphasized that the idea is to show the medical record in combination with other kind of information – if the user wants to make notes or read the record in more detail, s/he can enlarge the

component. It shall though be possible to enlarge the component but keep some information in the same view, for example the goal component when the care giver is about to write a note after a rehabilitation conference.

Calendar component



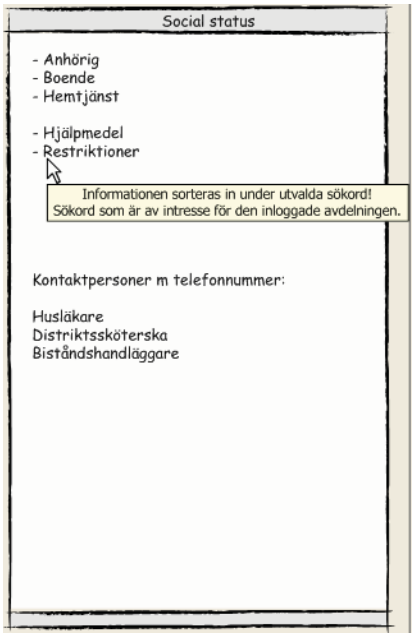
The idea of showing a calendar including the health issue related activities was received both positively and in a more critical way. Seeing a health issue focused activity list is not practically possible today, which may have caused the delay of positive reactions. When the users got the time to consider the use of such an activity list, most of them saw advantages with the component.

One of the nurses was pleased to get the opportunity to get a quick glimpse of the activities of today, and the week. Since the nurse is the centre of the ward, the one who is responsible for holding together an assortment of information, she is in need of a cross professional list over activities.

The occupational therapist and physiotherapist saw benefits implementing the calendar in *better communication* — they are both concerned to tell the nurse and assistant nurse when training is scheduled (so other activities can fit into the patients' schedule) in an easy manner. The therapists use several ways when trying to communicate with the care team; including notes on the notice board and memos on the whiteboard in the kitchen. These users believe that a joint calendar could improve this kind of communication.

One physiotherapist reported that her activities were often not very well planned, training was made when the patient felt ready and in good shape. It is hence hard to plan the daily activities in advance. A physician also meant that activities can switch very quickly at the ward, the patients health condition can change for the better or worse without telling in advance.

Social status component

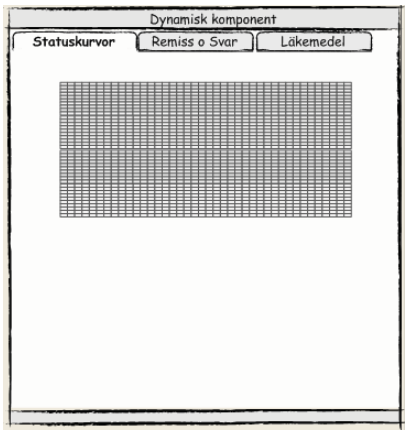


All users appreciated an easy access to social and personal information about the patient. A physician meant that this kind of information is important when trying to understand a new patient, and argued that this information is placed in a relevant area. One of the nurses said further that this information is important, especially contact information to other care givers, but discussed whether the information needed to be visible all the time. She hinted that the information could possibly be reachable by a tab in the overview, or something likely.

An occupational therapist compared the component with the care plan, where similar kind of information is written today. She argued that the care

plan does not get very much attention in its present form, it demands an active choice to get there.

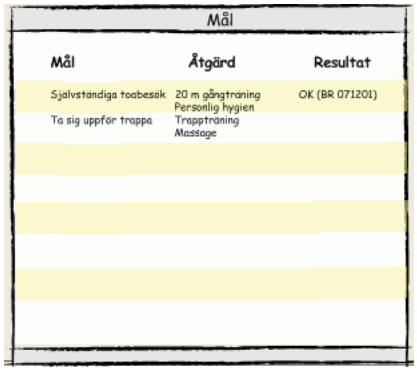
Dynamic object (where some components are dependent on the users' profession)



It agrees among all groups of users that a standard framework would be preferred since the care givers work in a team at the geriatric ward. However, it is also necessary to offer some profession-specialized information at the same time — to give the user a comprehensive picture of the patient's health issues based on the care giver's special aims of care.

A physician meant that a visual framework should preferably be adjusted in advance; it would be easier to scan a page that has a similar structure independent of the patient. He also meant that it would be good if the page could later be adjustable by the individual user, to some extent. "But the balance between individual adjustments and a common framework is a question which needs carefully consideration!"

Goal component

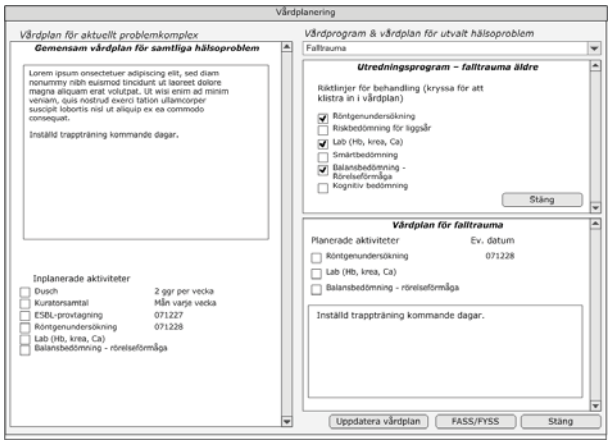


All users insisted on the necessity of high lightening the goals that the care team sets up for the patient. One assistant nurse told that the goals can often be neglected if the assistant nurse is not too motivated or well aware of the patient's actual goals. A visible list of goals would, according to him, stimulate a work that endorses the goals. It may for example be the case that a patient's goal is to walk independently to the toilet, but the goal may be opposed if the assistant nurse constantly uses the wheelchair by habit.

An occupational therapist said that the list should also include the goals that are fulfilled; that would cause better situation awareness since it would show both the actual and the previous situation.

It was furthermore reported that the goal component is interesting when the physician writes conference-notes; it would make it easier to give feedback at the goal if the goals would be visible in the same view as the medical record.

Implementation of clinical guidelines



The clinical guidelines and care programmes appear to be primarily important to the physicians, when planning the treatment of a specific health issue. Other care givers do not participate in this activity of planning care. The therapists are though planning the training-part of rehabilitation, which implies that they could possibly plan these activities in this area.

A physician said that the idea of

implementing guidelines and programmes is interesting, and would be helpful if it was simple to use. He approved the idea of showing the total care plan in relation to the clinical guidelines, it would help him to see whether the proposed care programme is possible to implement in the actual care plan.

The occupational therapist meant that the tool seems good in theory, but doubts if it would be practically possible to implement and use. She argues that her patients, at this ward, often have several health issues that have influence on each other. It would hence not be possible to cut and paste a care programme of a specific health issue into the care plan, since that treatment may conflict the treatment of another health issue.

The usefulness of the object in total

The users responded in general in a positive manner during the first evaluation, they appreciated the chance of getting a tool adjusted to their needs. The work process according to ISO 13407 advocates though iterative evaluations, which might have resulted in more varied answers. It is nevertheless the point that the users esteemed the idea behind the prototypes, but it is not impossible that the users would had given more dynamic answers at a second meeting.

A few users saw the design concept as a new way of handling the medical record; a chance of minimizing the frequently occurring "double documenting". A physician thought that the page could be seen as a wiki-page[7], where information were constantly changed and updated. He emphasised though that the changes, and whom they were made by, must be clearly visible.

Another physician pointed out that the prototype makes it easier to compare information, and to guarantee that the medication or treatment is right. He saw benefits in the prototype since it would make it possible to write a referral and at the same time be able to see the journal notes and the current health issues. He furthermore reported that he liked the opportunity to read the list of medication, and at the same time be able to compare it to the list of health issues. And vice versa.

Generally, the users reacted to the object as useful in their daily work; with some differences in the actual purpose and function. The lack of an all-embracing page seems unquestionable.

Situations when the prototype would be used

- Daily work (all care givers)
- The round (nurse, physician)
- Weekly rehabilitation conferences (all care givers)
- In the beginning of the shift (physiotherapist)
- To see if any news has appeared (physiotherapist, occupational therapist)
- When documenting (physician, nurse, physiotherapist, occupational therapist)

[7] Wiki = a homepage that can be edited by the users themselves. The first wiki was developed in 1995 by Ward Cunningham as an internal company system.

9. The design concept – a summarized discussion and conclusions

This final chapter discusses the advantages and disadvantages of the thesis's conceptual design, difficulties when developing IT-systems to the healthcare sector and the importance of a universal conception of the healthcare process.

9.1 Advantages and disadvantages of the conceptual design solution

Healthcare is a complex system, and the laws of secrecy combined with the pragmatic character of the care givers' work makes development of new IT artefacts complicated. What should be seen, and what should not, to give best possible care but still have respect to the individual? It is a complex question, which answer can only be determined on a national political arena.

It is a shared conclusion, by both the users and the supplier of the system, that it is hard to survey the patient's health situation in Cosmic — it takes time and it demands cognitive work at a high level since the care giver has to remember information from one module and compare it to information in another module. It is hence widely accepted that implementing an informational overview would simplify these tasks, and could thereby improve the users' *situation awareness*. But it is not an uncomplicated process to change the informational flows, as mentioned in chapter 3. Bossen (2007) concluded in an earlier study that a computerized POMR in Denmark led to fragmented information and a loss of overview. Bossen's results are interesting since the aim of this thesis was precisely to examine the overview that a computerized POMR could supply.

Situation Awareness – The pros and cons of a shared, common, HI-object

When designing the HI-object the hypothesis was that a structure and skeleton that was shared between *all* users in the care team would facilitate common situation awareness. Furthermore was the hypothesis that each profession would need some information that was dependent on the user; that a physician for example would need more medical information than the occupational therapist. When the design and evaluation phase in the cycle was iterated I started to question the hypothesis towards a more static HI-overview; an object independent of the user. The overall aim of the overviews might rather be to facilitate a common decision-making framework, than a specialized overview to satisfy each profession's specialised situation awareness. The overviews can provide an opportunity to create a shared vision, or mental model, of the patient's health issue. A shared mental model implies that the care givers also share an awareness of the actual situation. The situation awareness can be maintained and improved from monitoring these shared overviews. A common overview could also potentially support improved collaboration between different professional care givers.

A further idea would be to design an overview that is common to all users, and to adapt another overview that would be completely profession- and individual based. The specification of requirements shows though that the requirements are quite similar between different user groups, whereas individual overviews might not be useful. It could although be interesting to prototype and evaluate individual overviews in further iterations of the ISO-standard.

A possible disadvantage with a common and static HI-object could be that the user can feel too confined in the environment, an environment s/he cannot shape after her/his

own taste. The risk of designing a static overview is that the design will be adjusted to everyone and consequently not perfect to anyone. Dissatisfaction could lead to an object that would not be used, wherefore the overview would totally fall out of its aim.

A conclusion is nevertheless that a common structure and skeleton, independent of the patient or health issue, would improve situation awareness. If the user gets to know the designed skeleton s/he can more easily scan the page, according to e.g. Lif et al in chapter 4.2.3.

The design concept in relation to the workspace metaphor

The overviews can in my opinion be seen as two different workspaces, where the first overview would provide background information about a patient in the beginning of treatment whereas the overview of chosen health issues would provide an overview of the actual health issue state. The design concept is built on the belief that a common structure is essential to provide a solid framework of team work – which implies that the overviews would be quite similar independent on the user. The two workspaces would therefore not be adapted to a specific care giver; it would rather be adjusted to a care giver in a *specific situation*. To put the workspace in relation to Lif et al's design heuristics, it is evident that the design concept attests the first two criteria s*imultaneous presentation of information* (an overview with disparate information) and *pattern recognition* (a permanent skeleton and structure). The last criteria, the workspace *contents* shall have an obvious character that immediately reveals the kind of tasks that can be performed there, is not be attested in the design concept presented in the thesis. The design concept focuses rather on the overview function, than additional functions.

A further alternative to the described design concept would be to adjust the overviews in more detail to each group of users. This might be a future prospect of research, in other words to examine which tasks that would be in need of a certain workspace. In my study I made the conclusion that the users in many ways are characterised by teamwork, even if there exists profession-based characteristics as well. My further conclusion was though to primarily facilitate the teamwork spirit with a health issue based overview, to give common situation awareness.

Obligation to preserve secrecy – how may the overview affect the patient?

The fundamental idea with a medical record is to be able to give the patient the most possible safe care. At the same time there are problems with an all-embracing record. The most problematic area concerns secrecy. Shall it be possible to view if the patient has contacted a psychiatrist or not? An overview could without doubt present such information, but who can determine whether that kind of information is useful for the actual treatment or not…? Is it relevant for an orthopaedic to know that a patient is suffering of manic depression? The overview's design choices, concerning secrecy, will hence have direct ethical and political impacts, just as Löwgren & Stolterman (2004) argue (see chapter 4.2.3).

Guarantee of quality in healthcare

The evaluation sessions pointed out that the use of clinical guidelines could help decision-making, but it is not an uncomplicated tool. Since the patients often suffer from multi-disease (several health issues), it might be difficult to implement general guidelines. It might for example be the case that a care giver uses the guidelines when planning the treatment of a patient's health issues, but the guidelines does not take into account the interaction between different illnesses. Imagine that the guidelines for a

specific health issue would be directly dangerous to a patient suffering of a multi-disease, and the care giver still implements it into the care plan. Who shall then be held responsible of the maladjusted guidelines?

9.2 The definition of “Health Issue” is problematic and has influence on the design

The definition of health issue is of decisive importance when attempting to computerize a problem-oriented medical record. The study was based on the assumption that “health issue” could be defined as any reason for requesting care (it may be a diagnosis, or it may just be symptoms). However, this definition may be difficult to apply. A more narrow definition of health issues will possibly lead to several compositions of information, which in turn might not facilitate improved *situation awareness*. An example would be if a physiotherapist call a certain health condition A, whereas the physician diagnosis it to B, and the assistant nurse gives it the notation C. Information that in reality belongs to a specific problem will be divided into different definitions. It is at the same time harsh to determine that a common definition shall be used to the HI since a definition may be subjective, or be disagreed between different care givers. Disagreement, or a discussion concerning the health issue, shall nevertheless not be judged negatively – it may in the end lead to better treatment.

A narrow definition of health issue would furthermore complicate the graphical component in my prototype. If several minor health issues are to be seen it will take time and effort to understand the patient’s overall picture, despite the graphical component. A wider definition of the term could include minor symptoms related to a health issue – for example insomnia, tremor and disturbance of balance could be sorted under the health issue “Parkinson’s disease”.

The disadvantage of a wider definition would be the hesitation concerning the possession of some health issues – is a specific health condition a symptom to health issue A or B? Or could the health condition be related to both health issues? In my opinion, I think a wider definition could possibly hide information. It may be complicated to determine whether specific information belongs to one or several health issues.

Furthermore, the most common way when diagnosing a health issue is to name the diagnosis not until in the end of treatment. An approach could be to change the name of the diagnosis continuously, when the physician knows more and more. A health issue may in first be registered as “difficulty in breathing”, and in the later phase of treatment the definition may be changed to “asthma”. All information concerning the difficulties in breathing should later on be found under asthma.

Defining the term health issue is problematic but interesting, it is though not intended to elucidate the term in this thesis. The definition of the term is nevertheless crucial to the final design solution.

9.3 Future studies and further recommendations

This thesis has ended in a conceptual design of a health issue based overview, but further work is evidently remaining if the HI-object shall be possible to realise in the future. The iterative design process can be made in further steps; and develop the concept further on the basis of the results from evaluation. In later phases it should also be worthwhile to further develop the interaction between the user and the overview – to examine how the overview would behave in different situations, and how the overview would answer to a specific handling.

The design process described in the thesis has focused on the structure and skeleton of the overview; which implies that further graphical work with the components needs to be done on the surface level. Special effort is for example needed concerning the medical record component – how could it be technically possible to tag information to a specific health issue? Could the structure of the medical record be changed in any ways to better support a health issue based IT-system. Might it for example be the case that the documentation process could be reduced in the new system?

If the HI-object would finally be possible to implement it is also viable to examine how it would function in different wards and in primary care. The specification of requirements might differ between different divisions.

It can further be stated that the design concept has a clear patient focus, where it is possible to get a detailed overview of a specific health issue. It would be interesting to widen the discussion of health issues, and possibly develop an overview that has a ward- or profession focus. It could for example be interesting to an assistant nurse to get an overview of the ward's all actual health issues. These thoughts are though outside of my scope, but it might be an interesting area to examine in further studies.

My final recommendation would be to study the attitudes toward situation awareness in healthcare in comparison to sectors where the idea of situation awareness is well established. A frequently occurring example in articles of situation awareness is the workspace in cockpits. Aviation is a domain with high demands on safety, which has driven the knowledge of situation awareness. Healthcare is nevertheless a sector where safety is equally important; what aspects of situation awareness can healthcare learn from aviation?

10. Conclusions

The last chapter presents the conclusions of the thesis. The previous chapter described and discussed the complexity of implementing a new IT-artefact into healthcare, whereas this chapter will short and concisely answer the thesis's opening objectives.

How can a patient overview based on health issues be designed to give the care giver situation awareness?

A page where different kind of information is visible would be valuable; it gives possibility to judge health conditions in relation to other information. To be able to offer the care givers improved situation awareness it is important to design an overview pattern, with a well-conceived structure and skeleton, which can be learnt and familiar to all users over time and also easily recognizable.

Whether the overviews can facilitate faster situation awareness than the common EPR is hard to say. To measure such aspects one has to study users that have experience of using the overviews, which was not practicable in this study since the prototypes were not yet functional to that extent.

Would a HI-object be useful at a geriatric rehabilitation ward? In which processes?

It is legible that an overview of the patient's health issues would be useful. On account of the ward's characteristic team work, it would be of most use to introduce a common overview shared by all users. It was furthermore clear that the users had a similar foundation of requirements; the most interesting information concerning a health issue is often shared by all, or most, users. Shared overviews would facilitate improved ways of communication, and provide an opportunity to create a shared vision, mental model, of the patient's health issue.

Results from evaluation shows that the health issue overviews would be useful during the daily work at the ward to see if any new information has appeared, and more specific during the round, the rehabilitation conferences, during documentation and in the beginning of a shift.

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Interviews and discussions

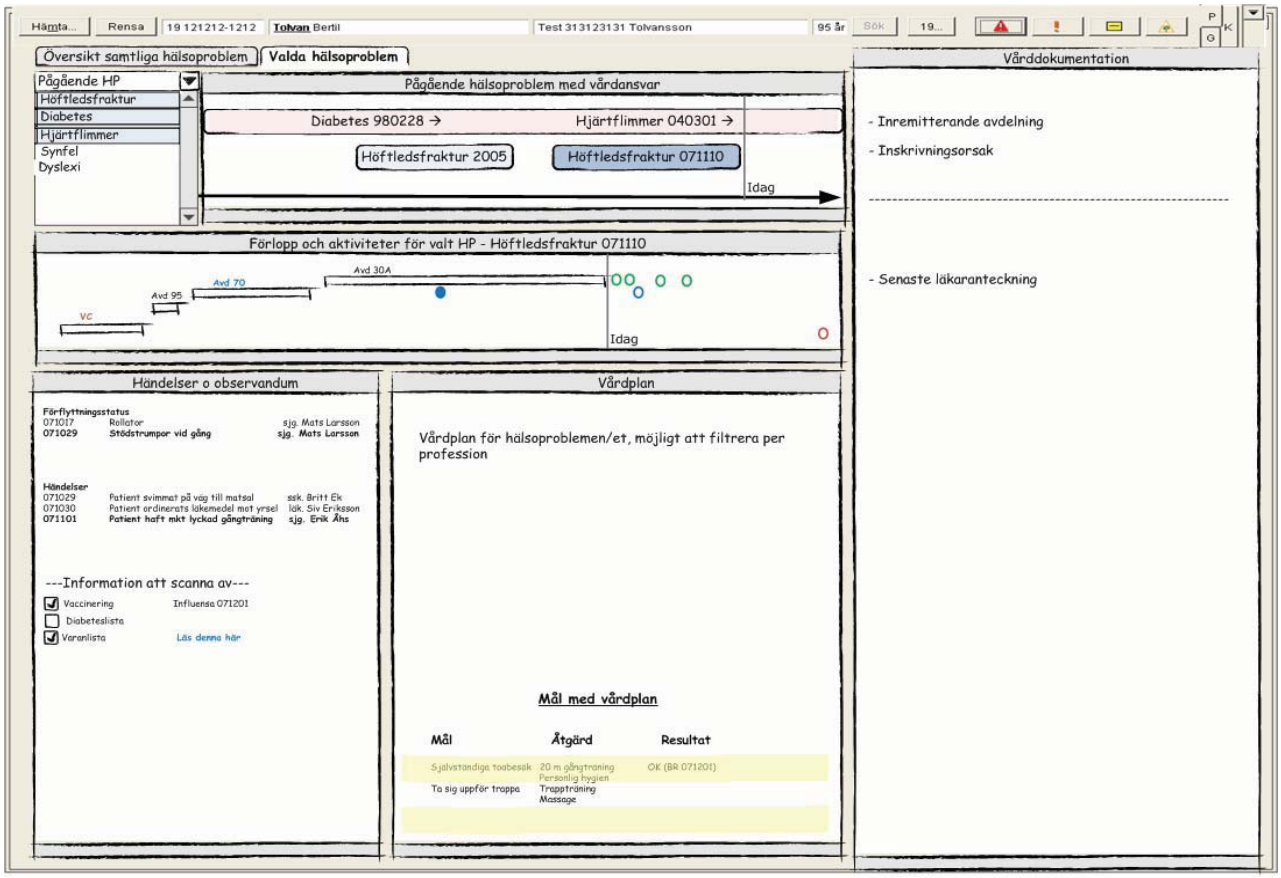
11 members of staff at ward 30 A, Uppsala University Hospital. Interviews and workshops.

Nordgren Håkan, Chief Medical Officer, Cambio Healthcare Systems AB. Continuous guidance throughout the project.

Wiman Martin, Interaction architect at Cambio Healthcare Systems AB. Continuous guidance throughout the project.

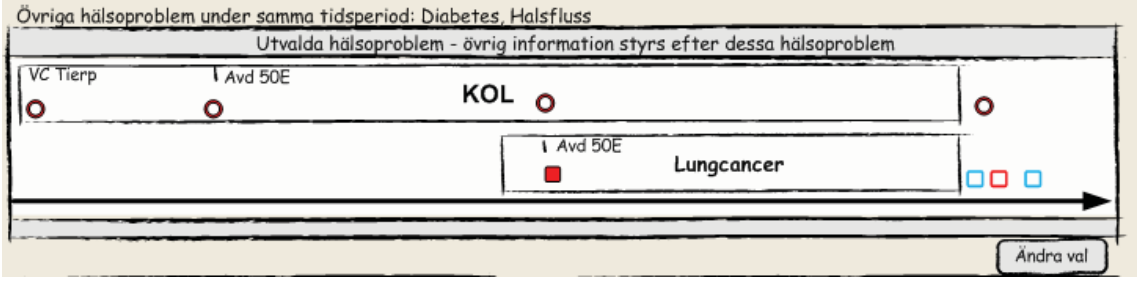
Appendices

Appendix 1: Versions of the tab ”Chosen health issues”

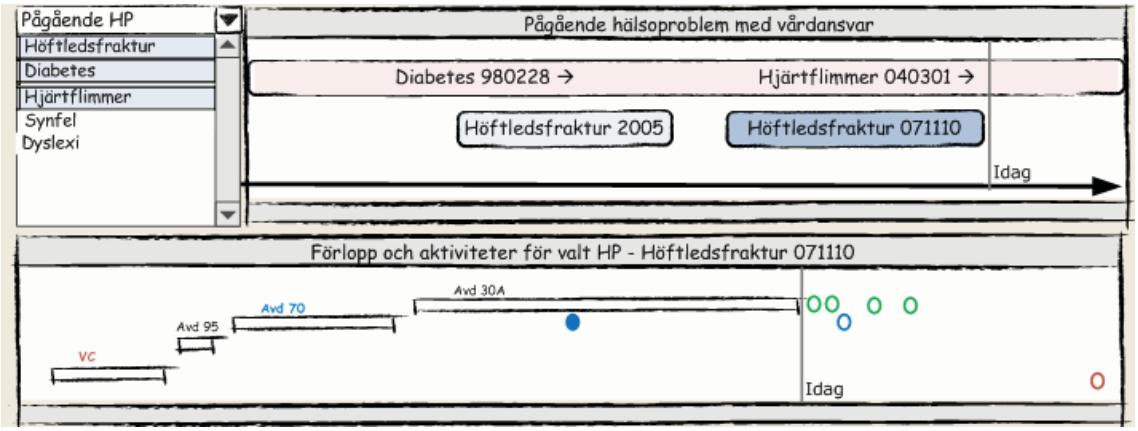


This version of the tab ”chosen health issue” present the same information independent on the user, it can be described as a prototype with a completely static skeleton. None profession-based information can be seen, but the medical record is enlarged. In addition to the status component there is also some ward specific information that can be scanned, it is represented by a list of check-boxes. In the centre of the view one can see the care plan – in other words, which kind of treatment that is planned (it may be instructions to handle a wound etc.). The graphical component is clickable, and updates the underlying component where it is possible to see the process of a specific health issue.

Appendix 2: Versions of the graphical component

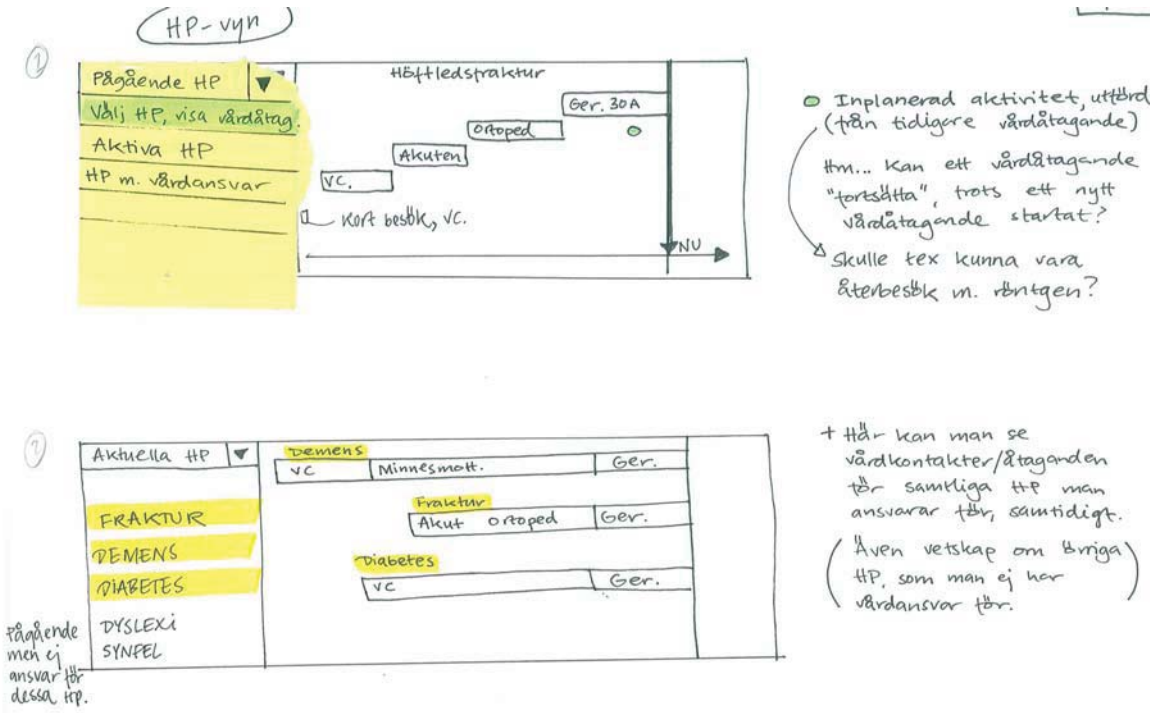


The figure shows a sketch of an enriched graphical component. It is enriched in the sense that it includes some activities connected to the health issue. It also shows the different care periods of the health issue. It should be possible to filter the information according to the care giver's needs, by the button in the right hand corner.



*This figure shows an alternative graphical component, that shows the activities and care periods of **one** chosen health issue. It could be possible to click on the different care periods to be able to read the discharge letter from the chosen care period.*

Appendix 3: Example of rough sketches



An example of mock-ups made during the project. Paper, pen and post-its were used for making quick sketchy prototypes. The prototypes were evaluated continuously, and marked with their advantages and disadvantages.