Building Usability into Health Informatics

Development and Evaluation of Information Systems for Shared Homecare

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Dissertation presented at Uppsala University to be publicly examined in Auditorium Minus, Gustavianum, Akademigatan 3, Uppsala, Friday, February 8, 2008 at 09:15 for the degree of Doctor of Philosophy (Faculty of Medicine). The examination will be conducted in Swedish.

Abstract

How can we develop usable and work process-oriented ICT systems for shared homecare?

Shared homecare involves different professionals, consists of mobile work and requires immediate and ubiquitous access to patient-oriented information, supporting an integrated view on the care process.

This thesis presents a new collaborative design method for user needs analysis and requirements specification in the context of health information systems development; the Multi-disciplinary Thematic Seminar (MdTS) method. The thesis also describes the MdTS method’s application and two different usability evaluations of the developed system.

The MdTS addresses a significant problem with health information technologies; they tend to support collaborative work of healthcare professionals poorly, sometimes leading to a fragmentation of workflow and disruption of healthcare processes. Based on human-computer interaction methods, MdTS implies a multiple-user needs analysis by thorough investigation of the entire interdisciplinary cooperative work and its transformation into technical specifications in order to develop appropriate information and communication technology (ICT) for the users’ differing work situations.

Application of the MdTS resulted in a prototype, the OLD@HOME Virtual Health Record (VHR), adapted to the specific demands in shared homecare. Through mobile devices each care professional accessed patient information in profession-specific views from an integrated platform.

This thesis provides an interesting case, illustrating how mobile ICT can support shared homecare, thereby bridging health and social care activities and improving knowledge about joint work processes.

Results from the usability evaluations were overall positive. Information needed at point of care was available on mobile devices and presented in an understandable manner. However, the evaluations also indicated that it is difficult to transfer results from one homecare setting to another due to differences in operational routines.

In conclusion, application of the MdTS method, in this study, succeeded in elicitation of correct user needs and in transferring correct requirements specifications to system developers for implementation.

Keywords: health informatics, participatory design, user centred design, homecare services, cooperative work, integrated health information systems, mobile devices, usability evaluation

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urn:nbn:se:uu:diva-8403 (http://urn.kb.se/resolve?urn=nbn:se:uu:diva-8403)
Che altri si vantino delle pagine che hanno scritto
io sono orgoglioso di quelle che ho letto

Jorge Luis Borges (1899-1986)
Preface

*Tell me and I forget. Teach me and I remember. Involve me and I learn.*

Benjamin Franklin (1706-1790)

List of original papers

This thesis is based on the following papers which are referred to throughout the thesis by their Roman numerals. Reprints were made with the kind permission from the publishers.


III  **Scandurra I**, Hägglund M, Koch S. Visualization and interaction design solutions to address specific demands in shared home care. *Stud Health Technol Inform, 2006; 124: 71-76*


V  **Scandurra I**, Hägglund M, Koch S, Lind M. Usability Laboratory Test of a Novel Mobile Healthcare Application with Experienced Homecare Staff (*Manuscript*)
Own contribution to papers

**Paper I:** *From User Needs to System Specifications: Multi-disciplinary Thematic Seminars as a Collaborative Design Method for Development of Health Information Systems*

**Description:** This paper presents a multi-disciplinary method (the MdTS) for the initial phases of system development in the context of shared home-care. The method implies a user needs analysis by thorough investigation of the entire interdisciplinary cooperative work and the corresponding transformation of this analysis into technical specifications, ultimately leading to the development of appropriate information and communication technology (ICT) for the variety of occurring work situations.

**My contribution:** I developed and conducted the method in the project OLD@HOME together with other project participants and I am the main author of this paper.

...//...

**Paper II:** *Specific Demands for Developing IT-Systems for Shared Home Care – A User Centred Approach*

**Description:** Based on experiences from applying the MdTS described in paper I, this paper presents the specific needs which ought to be considered when developing ICT systems for shared homecare. Results show both the information needed, attributed to mobile work situations, ubiquitous access to information and cooperation between professionals, as well as how the user centred design approach, applied in the MdTS, assists in improving cooperation in shared homecare.

**My contribution:** I was responsible in the user needs elicitation as well as in the analysis presented in this paper, of which I am the principal author.

...//...
Paper III: Visualization and Interaction Design Solutions to Address Specific Demands in Shared Home Care

**Description:** The objective of this work was to use visualization and interaction design to integrate different care practices into a collaborative work process. This paper presents design solutions that resulted from prototyping software solutions to meet the specific demands in shared homecare. Work was iteratively performed in a participatory design environment: developers, medical informaticians and usability architects worked together with the end-users.

**My contribution:** I was responsible for the design process; iterative sketching, storyboarding and prototyping of the “final” design, regarding user interfaces, navigational structures and use case production. I was consequently responsible for the paper. Moreover, I presented design solutions on the PDA at the demo session of Mobile HCI 2004 in Glasgow (UK) and PDA and web solutions at the MIE 2006 conference in Maastricht (NL).

…//...

Paper IV: Heuristic Evaluation Extended by User Analysis: A fast and efficient method to identify Potential Usability Problems in Health Information Systems

**Description:** This paper describes a usability evaluation method to identify potential usability problems by inspecting the user interface and judging its compliance with recognized usability principles. A “potential user analysis” was added to the conventional Nielsen Heuristic Evaluation, improving the evaluation with regard to the future users of the system. User skills, knowledge, cognitive capacities and frequency of system use were considered.

**My contribution:** I was responsible for the entire evaluation of the resultant system. This included; the concept of extending the conventional method to include a user analysis, coordination of the inspectors conducting the evaluation, and consequently the analysis of the results and subsequent write-up.

…//...

Paper V: Usability Laboratory Test of a Novel Mobile Healthcare Application with Experienced Homecare Staff

**Description:** This paper describes another usability evaluation method; in a usability lab eight homecare assistant nurses (first time users) tested the resultant system while performing a series of tasks related to their daily work. The test protocols were analyzed with regard to effectiveness, potential usability problems and user satisfaction.

**My contribution:** I was responsible for the entire evaluation. This included; the education of the experienced homecare staff, the evaluation containing learning sessions, coordination of the test according to the test plan and analysis of the results. Finally, I was the main author of the paper.
Co-authors

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Other contributions

I was invited to present my research work at the doctoral consortium of INTERACT’2005 where I had the opportunity to discuss research goals, methods and results with a senior assembly consisting of John Karat, Matthias Rauterberg, Wendy MacKay and Alistair Sutcliffe. Mark Apperley and Maddy Janse also reviewed my work.


Other first author publications

The results of my research were disseminated in various forms, i.e. scientific publications, posters, demonstrations at conferences and other workshops, as well as in project reports. I am the primary author of the following articles, which were not included in this thesis.


Other publications as co-author

Vimarlund V, Olve N-G, Scandurra I, Koch S. Organizational effects of the use of information and communication technology (ICT) in elderly homecare – a case study, Health Informatics Journal, accepted


Hägglund M, Scandurra I, Koch S: Virtual Health Record - user specific information access in a mobile work situation, WC2003-World Congress on Medical Physics and Biomedical Engineering, Sydney, Aug 2003


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<tr>
<th>Abbreviation</th>
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<tr>
<td>AN</td>
<td>Assistant Nurse</td>
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<td>CSCW</td>
<td>Computer Supported Cooperative Work</td>
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<td>DN</td>
<td>District Nurse</td>
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<td>GMV</td>
<td>Group Median Value</td>
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<td>GP</td>
<td>General Practitioner</td>
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<td>HCI</td>
<td>Human Computer Interaction</td>
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<td>HE</td>
<td>Heuristic Evaluation</td>
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<td>HHS</td>
<td>Home Help Service (Personnel)</td>
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<td>HI</td>
<td>Health Informatics</td>
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<td>Hi-Fi</td>
<td>High Fidelity</td>
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<td>HIS</td>
<td>Health Information System</td>
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<td>ICT</td>
<td>Information and Communication Technology</td>
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<td>ISO</td>
<td>International Organisation for Standardization</td>
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<tr>
<td>Lo-Fi</td>
<td>Low Fidelity</td>
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<td>MdTS</td>
<td>Multi-disciplinary Thematic Seminars</td>
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<td>MI</td>
<td>Medical Informatics</td>
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<tr>
<td>PD</td>
<td>Participatory Design</td>
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<tr>
<td>PDA</td>
<td>Personal Digital Assistant, handheld device</td>
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<td>POC</td>
<td>Point of Care</td>
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<tr>
<td>RCT</td>
<td>Randomized Controlled Trial</td>
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<tr>
<td>UCD</td>
<td>User Centred Design</td>
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<td>UCSD</td>
<td>User Centred Systems Design</td>
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<td>UI</td>
<td>User Interface</td>
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<td>VCP</td>
<td>Virtual Care Plan</td>
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<td>VHR</td>
<td>Virtual Health Record</td>
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<td>WPR</td>
<td>Web Portal for Patients and Relatives</td>
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Definitions

Regarding healthcare practice

Patient care process – the sequence of treatments and other activities, performed by healthcare or social care personnel for the patient, and in which the patient and often his/her relatives participate (Winge, Johansson et al. 2007a).

Home healthcare in Sweden can involve:
- Basic healthcare – provided by nurses and/or assistant nurses, and is in many cases, the responsibility of municipalities, but can also be outsourced to primary care units run by the county councils.
- Advanced healthcare – lead by physicians and provided by teams of physicians, nurses and other staff, and operated by the county councils. This care often concerns severely ill children or patients in palliative care. (Winge, Johansson et al. 2007a)

Social care – personal care involving help with cleaning, shopping, providing food etc, and other care that may physically support the patient, such as help with outdoor activities or personal hygiene. In Sweden, the municipality is responsible, however this type of care can be provided by either the municipality or by private companies contracted by the municipality. (Winge, Johansson et al. 2007a)

Continuity of Care - an organizational principle, where one or more healthcare providers deliver several healthcare services to a subject of care. This organizational principle focuses on the time related links between those different healthcare services (CEN 2000-09-19).

Shared Care - an organizational principle where two or more health care providers jointly co-operate to provide health care services to a subject of care for a continuing health issue. This organizational principle focuses on joint objectives and responsibilities (CEN 2000-09-19).

Seamless Care - a quality principle, focusing on the timely and appropriate transfer of activity and information, when responsibility for the delivery of health care services is entirely, or partly, transferred from a health care provider to another (CEN 2000-09-19).
**Integrated Care** - an organizational principle, encompassing at the same time each of continuity of care, shared care, and seamless care (CEN 2000-09-19).

**Care Plan** - description of planned and duly personalized services bundles, addressing one or more health issues, and encompassing all healthcare services to be provided to a subject of care by one healthcare professional (CEN 2000-09-19).

**Homecare staff** - in this thesis homecare staff regards assistant nurses, district nurses, registered nurses, home helpers and general practitioners as a group, as all these professions perform health and/or social care activities in the patient’s home.

**Clinicians, care professionals, healthcare staff or healthcare practitioners** are regarded as synonyms of healthcare professionals.

**Clinical domain expert** is a term used for healthcare professionals in relation to research in ICT development.

**Regarding ICT in healthcare**

**HIS - Health Information Systems**, defined as comprising all computer-based components which are used to enter, store, process, communicate, and present health related or patient related information, and which are used by healthcare professionals or the patients themselves in the context of inpatient or outpatient patient care. This definition includes e.g. documentation systems, decision support systems, archiving systems, ward management systems, operational planning systems, report writing systems, general practitioner systems, and telemedical systems which are based on IT solutions. (Ammenwerth and Keizer 2005)

**EMR – Electronic Medical Record** generally refers to computer-based clinical data of an individual that are location specific and kept by a single physician office or practice, community health centre or possibly an ambulatory clinic. (Protti 2007)

**EPR - Electronic Patient Record** generally refers to computer-based clinical data of an individual that are location specific and kept by a single healthcare organization such as a hospital, acute care or regional health authority. (Protti 2007)

**EHR - Electronic Health Record** generally refers to computer-based clinical data of an individual that are available across multiple locations. It is sometimes referred to as a **longitudinal health record**, which includes data about the individual from a number of different interoperable EMRs and EPRs. An EHR is shared across jurisdictions such as primary and secondary care. (Protti 2007)

**ECR – Electronic Care Record** is an emerging term that generally refers to computer-based data of an individual that are available across multiple locations. More specifically, it is seen as a record that is shared by healthcare practitioners and social services professionals. (Protti 2007)
**VHR – Virtual health record** = our term for a longitudinal health record. VHR includes data about the individual from a number of different interoperable EMRs, EPRs and ECRs and are available across multiple locations. It is shared by different healthcare practitioners and social service professionals as well as patients and their relatives or other significant persons. Relevant data from different feeder systems are aggregated and monitored at the point of care, for instance at a patient’s home.

**VCP – Virtual Care Plan** = our term for a longitudinal electronic collaborative care planning module (as part of the VHR) that is shared by healthcare practitioners, social services professionals as well as patients and their relatives or other significant persons. More importantly, the VCP is used on a regular daily basis.

**Regarding development of ICT**

**HCI – Human-Computer Interaction**, a research discipline concerned with design, evaluation and implementation of interactive computing systems for human use, and with further study focused on the major phenomena surrounding these systems (http://sigchi.org/cdg/cdg2.html#2_1). HCI is associated with usability and human factors in a system context. In this thesis *Usability Engineering* and *Human Factors Engineering* will be regarded as equivalent areas.

**Conventional system development methods** – In this thesis conventional system development will regard structured approaches often applied by industry. Common for conventional system development methods is that they apply a *system perspective*, as described by (Kammersgaard 1990), where all descriptions are based on system functionality. This is further elaborated in section 3, *Research Process*.

**User centred design process** - There are numerous differences between conventional system development methods and a user centred design process, also further described in section 3. Predominant is that the conventional methods review the system development phases back to the system specification and not until the system is deployed usability problems are adjusted. In the *user centred design process* feedback during development returns to the *users*, potential usability problems are immediately adjusted and designs are iteratively user tested.

**Complex sociotechnical systems** are defined by characteristics such as: large problem spaces; social; heterogeneous perspectives; distributed; dynamic; potentially high hazards; many coupled subsystems; significant use of automation; uncertain data; mediated interaction via computers and disturbances. (Vicente 2000)

**ICT system** – denotes the technical construct of a complete ICT solution; hardware, software, including basic software and communication network. Other terms used in this thesis, usually considered parts of an ICT system, are *application, ICT tool, prototype and design solution*. 
Regarding evaluation of ICT

*Health informatics evaluation* is the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context. (Ammenwerth, Brender et al. 2004)

_Evaluation_ - (in short) acts related to measurement of system characteristics in a decision-making context (Brender 2006) [p. X]

_Assessment_ – an overall sense that does not distinguish between retrospective objectives of the study aims, whether it is evaluation, verification or validation. (Brender 2006) [p. X and section 2.1]

*Validity* - determines whether the research truly measures what it was intended to measure and how truthful the research results are.

_Reliability_ – is the extent to which the measurements of a test remain consistent over repeated tests of the same subject under identical conditions.

*Validation* – the process of evaluating software to ensure compliance with specified requirements. (Are we building the right system?)

*Verification* – the process of evaluating the products to ensure correctness and consistency with respect to the specifications and standards provided as input. (Are we building the system right?)

*Usability* - the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a specified context of use. ISO 9241-11 (1998) (c.f. section 2.3.1 Usability evaluations)

*Utility* – regards whether the functionality of the system in principle can do what is needed (Nielsen 1994a).

*Useworthiness* – is the individual user’s assessment of the extent to which the technology meets the user’s high-priority needs, as a means of focusing on the importance of a product’s functionality in the user’s life or work situations (Eftring 1999).

*Usefulness* – is whether the system can be used for its intended purpose. (Nielsen 1994a). Usefulness is a generic term, not to mistake for usability.

*User friendliness* – is an (overused) vendor/layman term for selling a product, refers to anything that potentially makes using easier for novices.
1. Introduction

*We are on an island of change, in an ocean of tradition*

(unknown)

1.1 Problems in healthcare related to informatics

Research in medical informatics has resulted in the development of a large number of prototypes and/or systems. However, many such systems or prototypes developed did never overcome the prototype state or are only used in restricted settings by few clinicians (Koch 2003).

There are several reasons for the insufficient use of information and communication technology (ICT) in clinical practice. Many development projects are technology-driven instead of focusing on actual user needs, working environments and work processes (Maguire 2000). Without effectively considering these elements, the systems developed do not incorporate organizational knowledge into the ICT tool. The lack of user centred development and knowledge about the organization causes insufficient user focus, insufficient work process integration, and inhibits user acceptance. Moreover, lack of good human-computer interfaces has been identified as being a major impediment to the acceptance and routine use of many types of ICT systems in healthcare (Berg 1999; Patel and Kushniruk 1997; Tang and Patel 1994).

ICT systems that actually support healthcare professionals in their daily work are especially rare; focus has mainly been on administrative and technical rather than clinical issues. A number of specific challenges when developing usable clinical systems are lack of time, lack of interest for technical solutions and limited resources. Problems like these are important to overcome, since it is well recognized that medical devices which are difficult to use actually increase the number of human errors. (Sawyer, Aziz et al. 1996; Zhang, Johnson et al. 2003)

It is also well recognized that it is difficult to develop new ICT tools for healthcare personnel as many of these staff have none or little experience of working with ICT and have difficulties expressing their needs and requirements of the ICT system being developed (Berg 2003a; Stoop, Bal et al. 2006).
This calls for new methods for user needs analysis and development of ICT systems in healthcare. Suggested new methods include real user participation in the development process and development of ICT systems that are adapted to the healthcare environment and focused on effective and efficient ways to support clinical work processes.

1.1.1 Elderly Homecare

As homecare is becoming an increasingly important part of healthcare, the homecare sector was chosen as pilot domain for the research. There are different types of homecare, an important distinction is made between (1) basic homecare as a substitute for long term care facilities and (2) advanced homecare as a substitute for acute care (Hollander and Chappell August 2002; Winge, Johansson et al. 2007a). This research focuses on homecare of elderly patients, belonging to the first of these categories.

The Swedish population average of citizens aged 65 or over is 18 percent. A growth is expected from today’s 460 000 (5.2%) aged over 80 to 640 000 (7.2%) in the year 2025. This makes Sweden to the country in Europe with the proportionally largest elder population (Swedish Institute 2007).

Trends in recent elderly care show a move towards trying to shorten the time a patient spends in hospital care (Hollander and Chappell August 2002), increased effort to aid people remaining in their own homes, together with increased numbers of elderly citizens in need of care (Socialstyrelsen 2006; WHO 2003). Chronic diseases requiring monitoring and treatment, and usually a lifetime of medication, places high demands on the healthcare system (Swedish Institute 2007). These trends combine to create an increased care load (Wimo, Rönnbäck et al. 1999) set against shrinking resources within the healthcare sector (Socialstyrelsen 2006). To handle this, reliable and accepted ICT support is highly needed.

1.2 Demands for Shared Homecare

In many western countries, elderly homecare is shared between different healthcare provider organizations (Lind, Sundvall et al. 2002). In Sweden, elderly homecare is shared between county councils and municipalities.

Shared care is defined as situations in which clinicians jointly treat the same patient (CEN 2000-09-19; van Bemmel and Musen 1997). To be effective, shared care requires structured coordination of care activities, in which clinicians know what guidelines or protocols to follow and in which clinicians trust each other’s actions and interventions. Optimal communication is considered a vital aspect of shared care from both a clinical and a cost-effectiveness point of view (van Bemmel and Musen 1997).
Nevertheless, several studies have demonstrated that communication between clinicians about co-treated patients is prone to delays, is often incomplete, or erroneous (van Bemmel and Musen 1997) and that cooperation between different care providers in homecare needs to be improved (Andersson, Hallberg et al. 2003; Bricon-Souf, Anceaux et al. 2005).

Shared care requires participation of different healthcare professionals from several disciplines and therefore needs adequate tools to strengthen communication, to support cooperative work and to coordinate the care provided (Andersson, Hallberg et al. 2003; Bricon-Souf, Anceaux et al. 2005). Cooperative work and the need to access patient information when working in a patient’s home demand integration of health information systems (HIS), interoperability between the systems and mobile access to information (Figure 1). This is, however, not enough to fully support cooperative mobile work; other important factors are how to present the integrated or aggregated information for different care professionals, and/or for patients and their relatives, and how to design views, or user interfaces, that support specific mobile work situations and/or specific user groups.

Figure 1: Demands for shared homecare; to support cooperative work and to provide point of care accessibility of the information needed.
1.3 Support for Cooperative Work

In shared care, professionals from different organizations have to work together to provide high quality patient care. This requires strong collaborative working relationships, a clarity and commonality of objectives, frequent communication among team members, a clear understanding and respect of individual roles and skills within the team, and general flexibility of practitioners (Paquette-Warren, Vingilis et al. 2006).

Developing comprehensive and useful health information systems to support shared care is a complex task (Berg 1999), and although the need for ICT is acknowledged, there is still a lack of support for this type of cooperative work.

ICT tools in healthcare have traditionally only been developed for one care professional or specialist, whereas the entire care process is performed by several care professionals who communicate and share information. Moreover, the information and communication flow along the continuum of care is often not meaningfully integrated. Patient information is distributed among different HIS, impeding existence of a seamless and consistent patient centred workflow between the involved professionals.

Personnel from different care professions involved in homecare often only focus on their particular part of the work, and it is both difficult and time-consuming to reach a holistic overview of the work process. Moreover, meetings between care professionals belonging to different care provider organizations occur only rarely. This results in difficulties in coordinating work and maintaining up-to-date information (Winge, Johansson et al. 2007a). A patient receiving care under such conditions may not receive the appropriate care, and can be subject to unjustified interventions or left without proper intervention (van Bemmel and Musen 1997).

In order to support cooperation and coordination within the team, it is crucial that all care professionals have access to the documentation they need, irrespective of which organization the information derives from.

However, giving users access to integrated documentation gathered from several HISs increases the risk of cognitive information overload. It is therefore of utmost importance to thoroughly distinguish actual needs for each user group and to present correct and understandable user interfaces.

1.3.1 Care Processes to Enable Continuity of Care

As stated above, when care of a patient is shared between different care provider organizations it becomes difficult to provide coordinated continuity of care. Specifically, it becomes difficult to support the seamless treatment of a patient within the shared care process. Lack of communication and coordination can disrupt the continuity of care, leaving the patient in a vulnerable, sometimes even dangerous, position.
In recent years, either as a part of the ICT development or for organizational reasons, many Swedish projects\(^1\) have been focusing on identifying and describing the *care process*. Often these projects have been focused on identifying general work processes performed by care professionals in a patient case, in order to form a process model. Some projects (VitaNova, Intercare, Sams and Samba) took a broader perspective, and attempted to describe the shared care work process explicitly in form of the general work process of each organization.

However, few projects demonstrate a seamless information flow *between* homecare, primary and secondary healthcare, and the *patient care process*. The patient care process is defined in the MobiSams project (Winge, Johansson et al. 2007a) as the sequence of treatments and other activities performed by healthcare or social care personnel for the patient, and in which the patient, and often his/her relatives, participate. In *paper I* we found that in shared homecare, it is necessary to focus on the intersection points between participating organizations and to reach consensus between different parts of the work process, in order to be able to develop an ICT system that supports the entire care process (Scandurra, Hägglund et al. 2007). To provide continuity of care for an individual patient, local care processes have to be supported. In this context, general descriptions of the care process are useful as they provide a framework for more detailed specifications. The care process must also be kept patient centred to ensure continuity of care. Further, for inter-organizational communication and cooperation, it is important to identify the detailed and specific information needs for communication between the various healthcare organizations.

### 1.4 Mobile Access at the Point of Care

Despite the mobile nature of homecare, mobile ICT supporting the work are rarely available. Generally, homecare documentation is done on the healthcare professionals’ respective stationary system in the office, or on paper, and the systems are autonomous and incompatible. This impedes access of documentation where it is needed, at the point of care (POC), with the POC generally being at the patient’s home.

Mobile professionals need mobile tools, and in inter-organizational cooperative work, such as shared care, they need not only documentation from their own organization but also access to shared information. Information gathered from several documentation systems and displayed on small mobile devices increases the risk for cognitive overload. Cognitive aspects together with the inherent technical constraints of small devices, e.g. limited screen

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\(^1\) VitaNova, Sams, Intercare, Samba, MobiSams, Visi Point, RegionIT, Tillit, VIHO, OLD@HOME
space and limited interaction with elements on the screen, add complexity to the design of support systems in a mobile context of use. Hence, to prevent misunderstandings design of the user interface (UI) must take into consideration that the kind of information needed at POC and the optimal way of presenting it differs between care professions and between different work situations. As Luff and Heath have shown, misunderstanding the nature of mobile work can be problematic and can lead to ICT tools being used for unintended purposes (Luff and Heath 1998). To address this, special attention must be given to the work environment and context where the ICT will be used. At the same time, consideration must also be given to the constraints in the technical environment. This includes factors such as the limited screen space and interaction techniques noted above.

1.5 Health Informatics and Human-Computer Interaction

Many scholars have examined health informatics with special focus on usability and human factors. In fact, researchers from the scientific discipline Human-Computer Interaction (HCI) have done much work in the healthcare sector. Vicente, for example, states that these researchers often have a special interest in the healthcare environment as it is particularly complex. Work analyses of complex socio-technical systems are somewhat different from standard HCI research and design (Vicente 2000).

The understanding of medical and nursing problem situations and clinical work processes as well as insight into the strengths and weaknesses of different technical solutions are mandatory when working with health informatics (HI). Despite this, usability issues have not received much attention within the HI area. This has resulted in a large number of developed ICT systems failing to support clinicians in their work (Berg 1999). It is argued that ICT systems in healthcare must be designed with consideration of information requirements, cognitive capabilities and limitations of the end users, as well as consideration of daily work and organizational specific processes and practices (Andersson, Hallberg et al. 2003; Patel and Kushniruk 1998).

It is therefore of great importance to bridge the gap between these two disciplines and to create a synergy where methods and knowledge from both areas are used (figure 2). The cross-disciplinary HI-HCI approach benefits from both research areas. It retrieves knowledge from the HCI area, and solves problems in the HI area by implementing systems that focus on usability, while being developed according to HI standards and models.
It is important that this bridge, created by cross-disciplinary research, also incorporates the needs and environments of clinicians. This factor must be considered throughout the entire research and development process, from user needs elicitation to summative assessments. Although it is important to develop a system using the right methodologies, it is even more important to develop the right system. In sum, this interdisciplinary approach is valuable in order to create systems that are both verified and validated.

1.5.1 Research Objectives

My academic background and previous work experiences mainly consist of system engineering where results showed that emphasis on social and human factors was important. My research is therefore based on the assumption that incorporating knowledge from HCI into HI will improve both methods for system development and the usability of the resulting information systems. My main research question is synthesized as follows:

*How can we combine methods and knowledge from HCI and HI in order to develop usable and work process-oriented systems for homecare?*

This thesis concerns how to build usability into the development of ICT systems in a collaborative care context. To structure my response to the above research question, the research has been broken down into a number of more detailed questions. The detailed research questions are focused on
the system development process, and based on assumptions regarding support of mobility and cooperative work:

- **User Centred Design (UCD) and Participatory Design (PD) approaches in Healthcare**
  Understanding of not only one user group but several different users’ needs is crucial for development of ICT in healthcare. Conventional system development methods imply a separate, sequential needs analysis for each profession. In contrast, shared homecare needs a collaborative design method. This raises the question; how to elicit user needs and context requirements that support inter- and intra professional work?

- **Design solutions for mobile situations in homecare**
  In designing solutions for mobile situations in homecare, the following questions need to be answered: What are the specific and new demands in shared homecare? How can design solutions be adapted to mobile situations for different user groups?

- **Integrated health information to support shared homecare work**
  The ICT system needs to prove that it actually supports the personnel involved in the cooperative work. How can this integrated information support cooperation and coordination of work for different professions in a shared care team?

To answer these questions, this study applied a number of development and evaluation methods, originating from the HCI research and adapted to the shared care environment.
A range of theories and methodologies from human-computer interaction research (based on cognitive, social, and informatics sciences) have shaped my work. Primarily I have been influenced by user centred and participatory design approaches, which I apply by designing, implementing and evaluating an ICT system to support cooperative work in a homecare district.

In order to develop ICT systems that are easy to use and provide healthcare professionals with the information needed in their work situations, before any development is initiated, it is essential for developers and care providers involved to share an understanding of work routines, information demands, and other central preconditions at the clinical level (Andersson, Hallberg et al. 2003). Therefore, during system development my research is mainly based on observation and participatory seminar techniques for user needs and activity analysis, and on user centred design and an iterative development process containing usability evaluations. Methodological pluralism to increase understanding of the many perspectives concerning ICT in healthcare is advocated by a number of researchers, e.g. Kaplan (Kaplan 2001a), Ammenwerth (Ammenwerth, Brender et al. 2004) and Brender (Brender 2006). I apply a socio-technical approach (described below), and both quantitative and qualitative evaluation methods are used within the framework of action research, for validation of the results and for assessment of the applications.

2.1 Action Research

My viewpoint of HI integrated with HCI research is in accordance with the primary intent of action research: “to provide a framework for qualitative investigations in complex working situations” (Lewin 1947). Working in collaboration with real users in real settings we try to focus on today’s problems, finding solutions to immediate organizational and clinical problems (often by means of supportive ICT systems). Moreover, not only current issues will be handled, in order to create a successful (technical and organizational) system ideas about future work will also be generated.
The merge into practitioners’ daily work practice correlates with the view of actions research as

“...the way groups of people can organise the conditions under which they can learn from their own experiences and make this experience accessible to others.” (McTaggart 1991)

As such, action research is a qualitative research method that associates research and practice; research informs practice and practice informs research synergistically. Action research has its roots in social psychology were it emerged as a form of research in which researchers experiment through intervention and reflect on the effects of their intervention and the implication of their theories (Avison, Lau et al. 1999).

Conventional research is often seen as proceeding from point A to point B along a straight line; commencing with a hypothesis, proceeding with fieldwork and analysis to a conclusion, which may then be published in a journal. Instead of following the traditional linear research model, action research proceeds through cycles, ‘starting’ with reflection on action, and proceeding to a new action which is then further researched (figure 3). The process consists of four stages, all repeated throughout the duration of the project: plan, action, observation, and reflection/revision (McTaggart 1991; Wadsworth 1998).

![Figure 3: Cyclical action research process (Wadsworth 1998)](image)

Kurt Lewin, considered one of the founders of action research, states expressively when describing action research that:

“If you want to know how things really are, just try to change them”
(Lewin 1958)

I believe it is important for researchers of our kind, studying interactive ICT, to be involved in more than just the end users’ work. It is also necessary to affect and change users’ environments by actions such as the introduction of
new ICT and/or changed work practices and routines. In order for this to be successful, future work processes that include the new ICT system and their effects, need to be as anticipated as possible by the future users. Thorough evaluations are also imperative to produce new knowledge about ICT in different healthcare work situations.

2.2 Socio-technical Approach

Explanations for failure of ICT systems in healthcare are abound (Stoop, Bal et al. 2006). According to Berg, 75-80 percent are reported to fail (Berg 2003a). According to the methodological review by Despont-Gros et al (Despont-Gros, Mueller et al. 2005) several studies (Kaplan and Shaw 2002) (Lorenzi and Riley 2003) state that health information system failures typically fall into four categories: technical failures, project mismanagement, organizational issues and the explosive growth of information systems. Other studies show that less than 20 percent of the failures were related to technical problems (Aarts and Peel 1999), whereas organizational issues were the main culprit (Aarts and Peel 1999; Berg 2001; Kaplan and Shaw 2002; Southon 1999).

Poor design of HIS also affects the work environment and the individual work of the staff (Berg 2003b; Liljegren 2006). Due to deficiencies in the design in combination with general lack of ICT experience, staff in healthcare often feels helpless and frustrated when handling technology. These feelings can generate an increased sense of worry, stress and uncertainty in the staff’s daily routine (Persson 1992). Studies in elderly care have shown that many staff members have a defensive attitude towards ICT (Magnusson 2005; Sävenstedt 2004). These attitudes may conflict with the intent to introduce ICT in homecare in order to provide “a cost efficient alternative to residential care of elderly” (Hollander and Chappell August 2002). In worst case, attitudes and previous experiences could hinder introduction and usage of a properly working ICT system.

Berg (Berg 1999) advocates for the socio-technical approach as development of ICT needs to emphasize social, organizational, professional and other contextual considerations in order to improve the staff’s individual and organizational work situations. A socio-technical approach elucidates the various perspectives on healthcare. Moreover, it differs from more traditional views on development work in that it emphasizes the need to address cooperative work processes rather than discrete tasks for individuals (Berg 1998).

However, an approach, like the socio-technical, has to be more concretized to be usable in practice. Therefore, part of my work has been to create practical methods, based on the socio-technical approach.
2.2.1 User Centred Design and Participatory Design (Papers I, II & III)

On the social side of the socio-technical approach, studies of ICT focusing on contextual issues such as organizational, cultural or other social considerations have a tendency to be highly descriptive. There is an obvious need for procedures that bring an understanding of practice into specification design (Andersson, Hallberg et al. 2003; Crabtree 2000; Miettinen and Hasu 2002).

Unfortunately, there are as many definitions of design as there are designers. I will therefore start by defining my position on “design”. To me, the system development design process starts in the early development phase, where quality and features of a product are initially considered and discussed. For me, design is an iterative process stretching throughout the development of a system, including test and evaluation; it is not one phase in a linear method such as it is portrayed in a conventional system development method as e.g. the waterfall model. The User Centred Design (UCD) approach corresponds to my view of design. In UCD, Donald Norman identifies that:

“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 should dominate the design of the interface, and the needs of the interface should dominate the design of the rest of the system”. (Norman 1986)

I consider design and the design phase incremental. That is, it should continue to develop from the earliest design, through the iterative process of system development until final implementation and coding are performed, leaving design solutions as a result. Iteratively improved design solutions may help users experience future ICT systems in order to pose demands for it (cf. paper II “Specific demands” and paper III “Design solutions”).

I also agree with John Karat’s statements:

“For me, User Centred Design is an iterative process whose goal is the development of usable systems, achieved through involvement of potential users of a system in system design. “User Centred Design captures a commitment the usability community supports – that you must involve users in system design – while leaving fairly open how this is accomplished.” (Karat 1997)

The ISO 13407 (1999) standard “Human-centred design processes for interactive systems” advocates active involvement of users to reach a clear un-
derstanding of user needs and context requirements. Appropriate allocation of functions between users and technology, iteration of design solutions and multi-disciplinary design teams are suggested (figure 4).

There are different methods to reach the results desired in ISO 13404. In our research we apply User Centred Systems Design (UCSD) (Göransson 2004) which corresponds to my view of usability in the system design:

"User Centred Systems Design is a process focusing on usability throughout the entire development process and further throughout the system life cycle." (Gulliksen 2003)

However, although we are promoting user centricity and participatory design with users, users do not always know what is actually best for them, in terms of a new ICT system. How best to address the users’ needs or what is possible with ICT need to be related to other factors, such as organizational, technical and cognitive demands. In HCI, knowledge about human physical and psycho-cognitive skills is searched for; important to me is to adopt new findings from HCI ground research regarding information visualization and interaction design in the development and evaluation of HIS.

Participatory Design
Participatory Design (PD) is defined by Schuler and Namioka as a set of thinking, planning, and acting through which people make their work, technologies, and social institutions more responsive to human needs. PD practi-
tioners aim to improve conditions of work and the quality of life by involving users in design and development to shape technological and work outcomes that reflect their interests. (Schuler and Namioka 1993)

Methods involving participatory observations in the field (Bødker and Iversen 2002) are also referred to as PD. In this case, however, the users are not participating in a design environment, instead the designers are participating in the users’ daily work (Beyer and Holtzblatt 1995). PD is sometimes referred to as the Scandinavian approach (Bødker, Ehn et al. 2000) since this method was pioneered in Scandinavia during the 1970’s. The demand for participation derived from different political and industrial interests to improve and raise the productivity by empowering workers (through the workers’ unions) in the decisions of their environment (Bødker, Ehn et al. 2000).

"The focus of PD is not only the improvement of the information system, but also the empowerment of workers so they can codetermine the development of the information system and of their workplace” (Clement and Besselaar 1993)

Today, the political perspective on PD has decreased. PD is now primarily considered as an approach inspiring and encouraging a perspective where the future end users of a system are central actors in the development team. Due to the scope covered by PD, there is no single participatory design method. Rather, PD embraces notions such as:

"User participation is not restricted simply to the design of information systems, but inevitably brings in wider elements of working life."
"To attract the interest of users, it is important that the focus be on addressing their immediate needs.”

(Clement and Besselaar 1993)

**UCSD and PD**

The concepts of UCD and PD are often interpreted differently, depending on which discipline you represent, whether you are an academic or practitioner, whether your user population is well defined or not (Gulliksen, Lantz et al. 1999). UCD (or UCSD) and PD are very similar, almost equivalent terms. However, I view UCSD and PD as two overlapping sets, with an uncertain amount of overlap. Where PD is connected to empowerment of workers (Ehn 1990), the UCSD is limited to ensure the influence of specific users in a systems development process (Göransson, Gulliksen et al. 2003). UCSD can be performed even without end-users actively involved, although practical user participation always should be preferred. Where real users are not accessible, focus on the user can still be kept, for instance through personas, user scenarios or using representatives for the real users.
In Sweden, the work environment legislation facilitates user involvement, and thereby PD. The Swedish Work Environment Law states, among other things, that:

“the employee shall be given the opportunity of participating in the design of his own working situation and in processes of change and development affecting his own work” (Swedish, Work et al. 2006).

We chose to combine UCSD (Gulliksen 2003; Göransson 2004) and PD (Bødker and Iversen 2002) methods to actively involve real users in real settings to affect the development of ICT systems. Using a collaborative design method, users and developers apply techniques as described in paper I, II and III to shape both technology and the clinical environments where the new tools are to be integrated. When applying both UCSD and PD approaches the required empirical knowledge was made available in two ways:

(1), Through UCSD, end users are incorporated into the design process through consultation and user testing. An important part of this design stage is identifying specified users’ abilities and limitations in relation to technical issues.

(2) Through PD, different qualitative research methods are employed to grasp the context where the system is to be used. In this stage a key aspect is participant observation, and this should ideally form the starting point of any development or evaluation process (Berg 1999). Participant observation is recommended over standard user interviews, as participant observation provides a deeper level of insight into the user’s specific contextual issues.

Without field studies, system development can easily move away from the goal of meeting user needs. For example, developers may draw attention to technical challenges in the software, unaware of what is actually important when users perform a task.

2.2.2 Cooperative work (Papers I, II and III)

Cooperative work is conducive to cooperative design (Bødker, Grønbæk et al. 1993). Cooperative design shares important characteristics with PD; it considers design a social process (Greenbaum and Kyng 1992). In this thesis, I refer to cooperative work as the clinical work performed by several different healthcare professions. More specifically, cooperative work is the process of work - including the GPs, DN’s, and other care professionals - that results in successful overall patient care. Patient care is only successful when the work processes of all the relevant healthcare professions are connected effectively and efficiently.

In HCI research, the concept of Computer Supported Cooperative Work (CSCW) is commonly used when such integrated work is to be supported by
technology. The field of CSCW research emerged with the development of distributed computing systems and attempts to understand the socially organized (“collaborative” or “cooperative”) nature of work in order to embed such systems in the workplace (Crabtree, Rodden et al. 2005). Evidently, there is therefore considerable overlap in the problems addressed by research in PD and CSCW. Kensing and Blomberg state that at the heart of both is a commitment to designing systems (both technical and organizational) that are informed by and responsive to people’s everyday work practices (Kensing and Blomberg 1998). Their substantial article elaborates further on similarities and differences, concluding that PD makes no attempt to demarcate a category of work called cooperative but instead has focused on developing cooperative strategies for system design (Kensing and Blomberg 1998). In the research presented in this thesis, both PD and CSCW perspectives have been adopted.

In the case of shared care, or other work intricately shared between different professions, representatives need not only to come together from different disciplines, as in PD, but also from different professions within the target group, as in CSCW. Healthcare of today has evolved and increased in complexity, regarding both the way clinicians work and ICT use. Nevertheless, most care professionals only focus on their particular part of the healthcare process, and have little insight into the work of their colleagues. In addition, ICT has shifted focus from single user interactions on stand alone-machines to more complex computer-supported situations involving entire organizations and interoperable ICT systems. Thus, cooperative aspects of work need to be handled in interdisciplinary groups to achieve a common picture of the entire work process and of the support ICT could provide the cooperating teams.

**Common ground (Paper I)**

Healthcare professionals have a highly specified internal working language, and professionals generally adopt terminologies that are very specific to their domain. In addition to this, their spoken working language employed in healthcare is also highly specific, although local and profession-related dialects exist. In order to communicate efficiently between groups or professionals that use different languages, it is necessary to create a common ground of knowledge. The theory of common ground is defined by Herbert Clark:

> A proposition “p” is only common ground if:
> all the people conversing know “p”;  
> and they all know that they all know “p”.
> (Monk 2003)
Common ground is needed not only for communication in the multi-disciplinary discussion, but also for the resulting ICT system. Details of each profession’s internal language are crucial to incorporate in the ICT system in order to provide the desired support. Therefore, in shared care it is important that HI specialists and the care personnel involved allocate resources to reach an understanding of the different work processes of each care profession, as well as a common picture of the care process as a whole. Additionally, HI specialists also need to understand the specific terminology adopted by the technical and system development teams.

Multi-stakeholder involvement (Paper I)

Genuine participatory system development should include a wide range of consultation and consideration; only involving healthcare personnel may weaken the developed system (c.f. paper I, “Multi-disciplinary thematic seminars”). In addition to different end-user groups, other stakeholders such as buyers, owners, operational services and designers/developers, should be involved throughout the project according to the Institute of Electrical and Electronics Engineers’ (IEEE’s) recommendation of minimum set of stakeholders (IEEE Architecture Working Group 2000). This team approach reinforces the iterative process as each stakeholder group is told to review all decisions that concern them (figure 5). In this way, each design proposal is iteratively validated by all stakeholders to keep conformity with the overall goals.

![Figure 5: IEEE 1471-2000 – All stakeholders validate the iterated decisions and design solutions.](image)

2.2.3 Importance of Context (Papers I and III)

Pioneered by the sociologist Garfinkel, the methodological orientation of ethnomethodology has inspired HCI researchers with interest in computer
use within a social context (Button 2003). In this context e.g. Lucy Suchman bases her work on plans and situated actions (Suchman 1987).

The Situated Action approach views human knowledge and interaction as being inextricably bounded with the world, and claims that it is impossible to study phenomena extracted from their context (Suchman 1987). Vicente further explains that complex socio-technical systems, such as healthcare, are open systems, meaning that they are subject to disturbances that are unfamiliar to the professionals and therefore difficult, or even impossible, for designers to anticipate (Vicente 2000). Moreover, the design of the ICT tool will evidently have an effect on the work environment, once it is introduced:

“We are designing sub systems; the real system is out there already”

Muir Gray2, Key note speaker, Medinfo 2007, Brisbane.

Thus, it is crucial to design ICT systems that are tailored to help users perform open-ended intellectual tasks. When confronted with an unfamiliar and unanticipated problem, users must be able to take advantage of their domain knowledge to improvise and solve the problem.

The Contextual Design approach also stresses the importance of understanding the context in which an ICT tool is to be used. This approach aims to design products directly from an understanding of how the customer works. Compared to situated action, it has a more prescriptive approach and recommends abstractions and models to capture the ethnographic findings (Beyer and Holtzblatt 1998). Contextual design has primarily been used for design of information systems, but lately also adapted for use as a usability evaluation method (McDonald 2006).

Inspired by these views of ICT in a context, we developed the Multi-disciplinary Thematic Seminar method (paper I) to gather different perspectives of the surrounding environment where the shared homecare ICT system was to be developed. In particular, contextual design, as it frames different methods, suited our efforts to ensure that all factors relating to use of the system are identified before the actual development starts.

There are other famous approaches aiming to form a notion of context. In the book Context and Consciousness, e.g. Nardi (Nardi 1996) elaborates on context by comparing different theoretical frameworks; activity theory, situated action models and distributed cognition. I have however not performed any in-dept study of activity theory, although Nardi and colleagues (e.g. Kaptelinin, Kuutti and Engeström (Nardi 1996)) argue how, as a psychological theory, activity theory can be scaled to collaborative settings without loosing sight of individual participants in an activity.

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2.3 Health Informatics Evaluations

Although Randomized Controlled Trials (RCT) are the “gold standard” of clinical research, this research design is not adhered to in other scientific disciplines in medicine (Benson and Hartz 2000). In “Evaluating informatics applications”, Kaplan discusses the limitations of RCT and experimental evaluation approaches and favours social science approaches addressing questions outside the scope of RCT and similar evaluation designs (Kaplan 2001; Kaplan 2001a). Other researchers agree (Ammenwerth, Brender et al. 2004; Heathfield, Pitty et al. 1998; Kushniruk and Patel 2004), and the European Health Information Society defines health informatics evaluation as:

*The act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context* (Ammenwerth, Brender et al. 2004).

Consequently, other evaluation approaches have been developed: simulation, network analysis, ethnography, social interactionism, cognitive studies and usability testing among them. Kaplan argues for expanding evaluation approaches to enable increased understanding of the many influences concerning HIS development and deployment in order to improve these processes and their connection with patient care. (Kaplan 2001a).

In the *Handbook of Evaluation Methods for Health Informatics* (Brender 2006) Brender agrees but chooses to view evaluations from another dimension, presenting a framework for evaluations for Health Informatics in the context of the system’s life cycle, from project planning to ultimate implementation and support (Brender 2006). Evaluation methods are linked to typical tasks and activities in a system development or implementation project, stretching from the explorative phase, via technical development and adaptation to the evolution phase.

This perspective underlines the importance of evaluation throughout the development process and suggests an increasing variety of evaluations (Kushniruk 2002). In this thesis focus is on usability evaluations in healthcare.

2.3.1 Usability evaluations (Papers IV and V)

Usability evaluations are either designed as formative (constructive) or summative, with the designation depending on when the evaluation is employed during the development process (Hartson, Andre et al. 2001). A formative or constructive evaluation is made during the actual design process, with the purpose of finding usability problems to be dealt with and to control
a dynamically changing development process. In contrast, a summative assessment is made when the design is finished, to assess the result. Typical examples of summative assessments are evaluation of objectives fulfilment or assessment carried out in a contractual relationship, to assure the delivered system is in accordance with the contract (Brender 2006). Results deriving from the methods may be of either a qualitative or a quantitative nature. Furthermore, conventional methods for measuring usability are divided into two sub-groups: analytical and empirical methods. Analytical methods rely on the judgement of one or more evaluators inspecting a system. Empirical methods rely on data from actual users, either user performance or user opinions.

A range of evaluation methods deriving from HCI and concerning usability is presented in Brender’s handbook (Brender 2006). Different methods are appropriate for different phases in the system life cycle, and some methods are listed as appropriate for all phases. In this thesis, two different methods are applied as constructive assessments in order to improve the system being developed. One is analytical, the Heuristic evaluation (paper IV), and the other is empirical, the usability laboratory evaluation (paper V).

Previous research states that heuristic evaluation (performed by usability experts) and usability tests (involving real users) may be largely complementary. It has therefore been suggested that the two evaluation systems be used together in order to produce more valid results than either one used alone (Fu, Salvendy et al. 2002; Lathan, Sebrechts et al. 1999; Law and Hvannberg 2002). Based on these suggestions, I conducted the usability evaluations described in Paper IV and Paper V.

**Definition of Usability**

It is important to emphasize that usability is not only a single property of an application, but a combination of many different properties and attributes. Usability depends on how the system is designed. That is, it depends on who will be using the system, in which environment, and for what kind of work. Informally, usability issues can be thought of as how easy a product is to use. By laymen, this is often referred to as the product’s “user-friendliness”. More formally, the International Organisation for Standardization (ISO) defines usability as:

"the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a specified context of use"


Usability can also be related to the more general concept of *usefulness*. Nielsen (Nielsen 1994a) defines usefulness as how suitable a system is in terms of achieving a certain goal. Usefulness encompasses two concepts; utility and usability (Grudin 1992). Utility determines if appropriate functionality is
at hand while usability determines if the user is supported as defined by the ISO standard 9241-11. These three ISO criteria are the basis for my evaluations:

- **Effectiveness** is the accuracy and completeness with which specified users can achieve specified goals in particular environments.
- **Efficiency** is the resources expended in relation to the accuracy and completeness of goals achieved.
- **User satisfaction** is the comfort and acceptability of the system to its users and other stakeholders.

The purpose of a usability evaluation is to find (potential) usability problems that users encounter in “real use” (i.e. in the actual work context) and that affect the efficiency, effectiveness and satisfaction with which a user adopts a product, or in this case a health information system.

**Heuristic Evaluation (Paper IV)**

Heuristic evaluation (HE) is an established usability inspection method that investigates whether a user interface complies with recognized usability principles, commonly called heuristics (Nielsen 1994). It can be conducted at virtually any stage of the development life cycle and can be used repeatedly in a process of iterative or progressive refinement (Constantine and Lockwood 1999). The HE is considered a time and cost effective usability technique used to identify major usability problems of a product (Nielsen 1994a). The efficiency focus of this method makes it particularly well suited to aiding the future design and development of medical devices (Graham, Kubose et al. 2004; Zhang, Johnson et al. 2003) or telemedicine systems (Lathan, Sebrechts et al. 1999; Tang, Zhang et al. 2006).

*Paper IV “the Heuristic Evaluation”* details how I conducted a HE on the system being developed, the virtual health record (VHR). Our HE identified potential usability problems in the system and ultimately contributed to improving the VHR.

**Usability Lab study (Paper V)**

A usability lab study is the most commonly used empirical usability evaluation method. A usability lab study is also referred to as a usability laboratory test.

A usability lab study can be used during all phases of an ICT system’s life cycle: during the analysis and design phase, in connection with a delivery test and as constructive assessment during implementation or for adjustments of the functionality of a system that already is deployed.

The usability test is usually performed in three stages: preparation, test and follow-up (Nielsen 1994a). The preparation usually consists of
- Recruitment of users where the selected participants should have the same characteristics as the intended user group.
- Choosing the tasks to be evaluated. The tasks should be representative and cover relevant parts of the system that is intended to test.
- A test plan: Data need to be structured in advance, in order to analyze the participants’ performance efficiently.

The actual test is then performed, and the participants follow the tasks assigned to the test. Often participants are encouraged to think aloud while performing the test in order to gather more substantial and qualitative data. After the test, the users are debriefed, preferably using both questionnaires and interviews.

In the follow-up stage, the recordings are coded and collected data are analyzed. Specific problems found are analyzed in detail and results are reported. In Paper V, we followed the conventional usability lab procedure as described by Dumas and Redish (Dumas 1999).
General predictions have been made that ICT will not only change, but improve homecare. However, at this state this remains unconfirmed due to lack of full-scale studies. Currently, such studies can simply not be performed since there are very few systems complete enough and stable enough to investigate empirically. A major part of current research in this area is therefore still in the explorative phase, describing the problem area rather than providing concrete answers or solutions. In this context, my work can be seen as leading to improved empirical research, by actually providing some concrete answers and solutions.

I here start with a short description of the objectives of the larger project OLD@HOME. This project formed the basis of the major part of my research. I will subsequently discuss the details of my own research process.

The overall objective of OLD@HOME was to provide home healthcare with technologies that already existed in other domains, but which needed to be adapted to the specific needs of shared homecare. The objectives were defined as *efficiency goals* (Koch, Hägglund et al. 2004), or *visions* to strive for:

- increased quality, safety and trust for staff, patients and relatives
- more efficient coordination between care providers
- support to team-based work routines
- increased professional status and thereby enhanced staff recruitment

The *project goal* was to develop an ICT system to help fulfil the efficiency goals. However, not until the system is implemented and fully working in homecare, evaluations of the efficiency goals can be performed.

The efficiency goals were described on a high level of abstraction, and methods for reaching the goals were not established. My research process therefore started with a cross-disciplinary literature study to find relevant research and development methods.

In short, *conventional system development methods* adopt structured approaches and are often applied by industry. The methods are either depicted
as a waterfall model (Clarke 2000) or as an iterative and incremental process. The latter is predominant in system development methods like Rational Unified Process (RUP) (Joe DeCarlo, Enrico Mancin et al. 2007; Kruchten 2000). Common for conventional system development methods is that they apply a system perspective, as described by (Kammersgaard 1990), where all descriptions are based on system functionality. Focus is on what the system performs, not what the user does or wants. My own experience with conventional system development methods, as well as previous research (Beyer and Holtzblatt 1995; Hardstone, Hartswood et al. 2004; Hughes, Randall et al. 1993; Miettinen and Hasu 2002), further led me to observe that conventional system development methods often overlook requirements regarding points of intersection between the cooperating professions. Samaras and Horst claim that defective requirements are the principal cause of incorrect or inadequate system designs (Samaras and Horst 2005). More specifically, conventional system development methods usually involve a separate user analysis for each profession, or user group. Such a method results in identification of user specific issues, but does not fully address the points of intersection and/or overreaching issues. Thus, there is a need for methods addressing the weakness in conventional system development methods.

A difference between conventional system development methods and a user centred design process is for instance that the conventional methods review the system development phases back to the system specification. In the user centred design process feedback returns all the way back to the users. Moreover, our user centred design process is collaborative since it applies a multiple user group perspective in order to provide and receive iterative feedback from all stakeholders involved in the shared homecare work. This user centred design process is thus based on user centred design, influenced by CSCW, participatory design and by the context of use within healthcare and HI. Incorporating these perspectives, I formulated a general research assumption:

_A user centred design process, incorporating MdTS in the early development phases, will create ICT systems that better support shared homecare work processes, compared to when conventional system development methods are applied._

In the present thesis work, the process of testing this assumption was started. First, a new multi-disciplinary thematic seminar (MdTS) method was created (c.f. paper I) and applied in the development of prototypes and working applications for shared homecare. In comparison to conventional system development methods, the MdTS method should specifically result in (four research items):

1. a facilitated transfer of user needs to a system specification
2. a description of the agreed (system) context requirements
3. a low degree of usability problems
4. new homecare staff being able to use the system with a limited amount of introduction.

I thus assumed that the MdTS method, based on user centred and participatory principles with a multi-user perspective could better facilitate transfer of multiple user groups’ needs to system specification (research item 1). Whether improved transfer of user needs has been achieved can be measured by verification and validation tests. System functionality verification, exploring whether the system is correct and consistent with respect to the requirements specification, is performed in conjunction with examining whether the system solves the correct problem, the validation.

I also assumed that the MdTS method would result in a description of user needs and context requirements where all users agree (research item 2). I chose to value the user needs and context requirements description in terms of user agreement. In collaborative work, a requirement consensus is achieved when all users understand their own and the others’ purposes and goals and when an agreement on common purposes and goals of the system is reached. A description of user needs and context requirements therefore includes all different users’ individual intra- and inter-professional needs as well as the agreed common goals. When this description is considered fulfilled and verified by all users, it is an agreed description of context requirements (research item 2).

In order to validate the developed system, that is, identify whether a correct description of user needs and context requirements was achieved and transferred throughout the system development process, real users were asked to evaluate the system usability as described in paper V.

The evaluations of the developed system should also identify and rate potential usability problems. I define a low degree of usability problems as follows; relatively few problems are detected, but more importantly, none of the problems detected was rated as serious (research item 3). Usability issues were investigated in paper IV and paper V.

Another important issue that the development process should tackle was that new homecare personnel should be able to use the system with a limited amount of introduction (research item 4). New homecare personnel, in this case, was defined as those who were experienced in the homecare profession, but who were new to the technology. This was investigated in paper V by letting real home help service (HHS) personnel test the prototype in a usability lab. More specifically, these HHS participants evaluated the usability of the system by accomplishing relevant and frequent tasks required for their daily work.

This process, the underlying work of each paper and their relationships to each other are further elaborated below (figure 6).
My PhD work consisted in creating the MdTS method aiming to enhance the user needs analysis and the transfer of user needs to system requirements specification for development of ICT systems in shared homecare. This method is one part of the user centred design process. Other work in this process is not described in this thesis, as it regards more technical parts of system design, such as detailed information modeling, conceptual database modeling, and functional specifications.

Figure 6: The research process in relation to the user centred design process and evaluations of the OLD@HOME prototype.

The overall assumption (as described above and in figure 6) is however not completely verified in this thesis. Instead, the outcome of each paper was successively validated by the users of the future system and the result was presented in the consecutive paper. Moreover, results from the two evaluations (paper IV and V) indicated that MdTS is a useful method for correct user needs and context requirements analysis, but further investigations are needed.

The output from the MdTS method, the requirements specification, was compared to other project specifications. At that point, there was no means to confirm fully that the specified demands were correct. Thus, I investigated whether these demands, elicited in one homecare district, corresponded to demands gathered by other Swedish homecare projects with similar objectives. This comparison is further discussed in section 4.2.6 Comparison with similar projects.
4 Summary of papers

Construction is the core of changing reality – go ahead, program, test, do!
Nygaard/Dahl, Scandinavian tradition

The results are based on research within two action research projects. The main work was performed as part of the OLD@HOME project (Koch, Hägglund et al. 2004; Koch, Hägglund et al. 2005). The environment and specific circumstances, under which OLD@HOME was conducted, as well as the resulting system, are systematically discussed in my published papers. For this thesis, a summary of the published papers, including their specific research issues and questions investigated is provided below.

In paper I, I present a new multi-disciplinary thematic seminar (MdTS) method for user needs analysis and requirements specification in the context of HIS for shared homecare, based on PD and CSCW.

As a result of the user needs analysis, specific demands for shared homecare were elicited. These demands can be attributed to mobile care, ubiquitous access to information and cooperation between professionals. In paper II (Specific demands) the key components required for designing usable shared homecare systems are described. Based on these findings, design solutions were developed for a homecare work process. These design solutions are presented in paper III (Design solutions). Paper IV and paper V subsequently present two usability evaluations, a heuristic evaluation and a usability lab evaluation. Both of these evaluations were performed as a step towards validation of the user centred design process. In the other action research project, VIHO - Efficient Computer Support in Care for the Elderly project (Johansson and Sandblad 2006), application of the MdTS method and the demands found in OLD@HOME were verified.

4.1 The OLD@HOME project

The main purpose of the three year-project OLD@HOME was to provide a seamless and consistent information and communication flow between home healthcare and primary healthcare through establishment of a virtual health record (VHR). Using tablet PCs and PDA, the VHR allowed for mobile information access and expanded provision of documentation to homecare staff at the point of care (POC). (Koch, Hägglund et al. 2004) Focus was on
care of elderly living in private homes. The project was the result of a truly interdisciplinary process. It involved real users during the entire system development and deployment process.

Geographically, the project was located in the municipality of Hudiksvall, within the County Council of Gävleborg, in Sweden. Hudiksvall is a mainly non-urban, remote region. It has a population of about 37 000 inhabitants of which about 5.5 percent are aged over 80. This reflects the Swedish average of 5.2 percent of the population being elderly citizens (Swedish Institute 2007).

The region had established fiber-optic network infrastructure connecting all test site locations. These locations were two primary care centres, the elderly patients’ private homes and one nursing home for the elderly, from where homecare of the elderly was coordinated. At the nursing home and in some of the private homes, WLAN hotspots were installed. All WLANs were configured for maximum security. The combination of pre-installed and project-specific infrastructure enabled unlimited transmission of information, and provided an excellent platform to facilitate the OLD@HOME project (figure 7).

![Figure 7: The OLD@HOME technical infrastructure.](image)

4.1.1 Participants

Three groups of care professionals from different care providers were involved. These were:

1. general practitioners (GP; n=3 whereof one involved in development) and
2. district nurses (D; n=4 whereof two involved in development), employed by the county council, and
home help service personnel (HHS; n=14 whereof three involved in development), mainly assistant nurses who were employed by the municipality of Hudiksvall.

In addition to this, not only end-users were involved from the healthcare organizations. Other stakeholders as buyers/owners/operational services (IEEE Architecture Working Group 2000) were invited to initially set up common goals for the project (figure 5). Throughout the project life cycle they continued to validate the conformity towards those goals.

Multi-disciplinary working groups were formed according to the Triple Helix approach (Etzkowitz and Leydesdorff 1997) and engaged from the project start-up and throughout the development process. These included, apart from the healthcare professionals, also specialists working in:

1. a system development/technical issues working group (industry)
2. an evaluation group (containing domain experts/researchers from caring sciences), and
3. a patients and relatives group (containing both staff and real users).

Usability architects and HI researchers worked within all groups as team managers (figure 8). (Koch, Hägglund et al. 2005)

![Figure 8: The OLD@HOME multi-disciplinary working groups.](image)

The degree of ICT usage differed between the groups of healthcare personnel. Originally, GPs and DNs used both paper and digital documentation for recording information in their office medical and nursing record systems. HHS used only paper-based documentation. None of the groups used digital, mobile documentation facilities, or had digital access to documentation from any other group.

As explained in paper I, the multi-disciplinary working groups gradually developed and tested new work processes using prototypes of the VHR. As part of the project, the final VHR system was used for five months by the
three care professional groups who were regularly involved in the treatment of 18 elderly patients within one homecare district. During this test period, the three care professional groups included 14 assistant nurses (ANs) from the HHS, two DNs, and two GPs.

While the OLD@HOME project planned to involve 18 test patients that received care from both care providing organizations, the HHS performing most of the home visits became so comfortable with the system that they decided to use the VHR for all the elderly patients living in their district. This meant that from September to December 2005, the HHS used the VHR to monitor all 38 patients living in the homecare district. Eight relatives of the selected patients also chose to participate actively in the study. In doing so, these relatives had access to information about their elderly patient via a web solution. The relatives to the other patients were continuously informed about the broader progress of the project. Ethical approval and informed consent of all patients were acquired prior to performing the study.

4.1.2 The Virtual Health Record

The vision of the project was to provide the right information, in the right place, at the right time, for the right person, presented in the right way. To reach the objectives we developed an integration platform (figure 9) aggregating information from the care providers’ feeder systems, such as the DN’s and GP’s electronic health records, and enabling documentation at POC (Hägglund, Scandurra et al. 2007).

![Figure 9: The OLD@HOME integration architecture.](image)

Using different mobile devices (figure 7), each care professional, as well as patients and relatives, were able to access relevant patient information from
the integrated platform through a virtual health record (VHR). The VHR consisted of:

- a web application on TabletPC for GP and DN, with differently aggregated views depending on profession;
- a PocketPC application used on a PDA providing HHS other aggregated views, but equally relevant for their profession, and
- a web portal for patients and relatives (WPR) was also developed providing access to certain useful information for patients, their relatives and significant others (figure 9).

The VHR also included a modified prescription list for the HHS, an integrated care plan for DN, HHS and patients and relatives, daily notes, risk factors, and status updates from all feeder systems (Koch, Hägglund et al. 2005; Scandurra, Hägglund et al. 2006). Some user interfaces are illustrated in the Design Solutions section (4.3) in this chapter.

Technically, implementation was based on Microsoft .NET, using BizTalk Server 2004 as platform for information handling, SQL Server 2000 and SQL Server CE 2.0 for data storage, SharePoint Portal Server for handling of Web-portals, and XML as format for data exchange. Microsoft Visual Studio.NET and .NET Compact Framework were used as developer platforms. Microsoft Authorization Manager (AZMAN) was used for handling of access rights. An external firewall was used to fully secure all communications and to prevent illegal remote access to central server systems.

From July to December 2007, the VHR system was upgraded, providing the HHS with an improved platform and new devices that are currently being used. The upgrades included: BizTalk Server 2006; SQL Server 2005; SQL Server 2005 Mobile edition for database management system (DBMS). For all communication Secure Sockets Layer (SSL), pin-code, user name, password as well as encrypted local databases on the mobile units were used. All new mobile units were based on Windows Mobile 6. Modifications resulting from the usability evaluations (e.g. paper IV and V) were incorporated in the upgraded applications.

4.2 Multi-disciplinary Thematic Seminar Method (Paper I)

I assumed that if system development was performed using a user centred design process and with end users from the homecare domain as participants in the development process, the final system would better support the integrated work process of the homecare professionals and thereby patient centred care, compared to if a conventional system development method was followed.
The first step in the development of an effective and efficient ICT system for the homecare domain was therefore to develop a method to elicit and manage the overall collaborative ICT needs. *Paper I* introduces the MdTS method. The paper explains how the MdTS captured user needs for different professionals, work situations, and environments in order to improve collaboration in future work processes. Moreover, the method supported the transfer of user needs into technical requirements specifications. In this way, the MdTS method was different from previous methods, which either were not sufficiently detailed to support system implementation or lacked focus on the points of intersection between different user groups.

Previous research regarding the process of user needs and context requirements gathering, reminds us that “actual requirements pre-exist our efforts to capture them” (Woolgar 1994). This means that we, as ICT developers, must be careful not to create requirements that fulfill our own technical desires. This concept is particularly important in domains where users are generally less familiar with computer technology, or in domains were users collaborate in a non-computerized environment. Traditionally homecare is a case example of this type of domain. Identifying real requirements in this domain can be particularly challenging as the professionals often neither know the requirements, nor can articulate them. To overcome this issue, the MdTS method emphasized the need to understand the different homecare work processes, as used by different professions. The homecare work processes were also considered from a holistic and a detailed perspective. This understanding further enabled us to develop an ICT system and simultaneously assisted in restructuring and streamlining the collaborative work processes of HHS personnel.

4.2.1 Theoretical description of the multi-disciplinary seminars

The MdTS method combined a number of known user needs analysis techniques to envision future work and to clarify the actual work process for all participating user groups incorporating both holistic and detailed perspectives.

The predominant part in the MdTS method is the thematic seminars, carried out in a seminar series. Preceded by pre-seminar observations and interviews, the seminars were performed as multi-disciplinary work in inter- and intra-professional working groups (figure 10). The seminars were performed in an iterative way and contained both a holistic and a detailed perspective (figure 11).
Figure 10: A multi-disciplinary method for user needs analysis in shared care.

In paper 1, the multi-disciplinary working groups consisted of DNs, HHS and other healthcare personnel involved in the homecare process. These groups completed iterative tasks. Each task aimed to clarify how collaborative work processes could be improved via the use of ICT, thereby verifying and validating the proposed design solutions (figure 10).

During the seminars, future work was emphasized. Nevertheless, we recognized that direct questions like: “How do you want to work in the future?” or “How would you like the new ICT system to be?” seldom resulted in constructive and visionary answers (Hardenborg 2007). In short, it is difficult to initiate user envisioning and special methods are needed to reach these goals. I illustrate this by a statement by Henry Ford, that once said:

If I had asked my customers what they wanted, they would have asked for a faster horse.

Research shows that when users are asked about future requirements without envisioning activities and time for reflection, current practices risk being conveyed into the future system, routinely and without questioning. Put more poetically, “Old cattle trails are being asphalted” (Hardenborg 2007).

Figure 11 shows the twelve seminars that were selected to step by step carry out the multi-disciplinary work. The chosen thematic topics covered a range of current and future work practices, incorporating exercises to bring out both holistic and detailed information. The first six seminars were focused on knowledge gathering with respect to the general homecare work processes (i.e. gaining holistic information), while the final six seminars analyzed the results in detail.

Although, the themes were not necessarily held in consecutive order, the complete seminar series aimed to encompass the necessary knowledge of work situations in shared care for development of a flexible and “future-aware” VHR. It is important to note that MdTS involved representatives...
from all professional homecare disciplines, even though focus was on DNs, HHS, and GPs.

4.2.2 Application of the multi-disciplinary seminars

The MdTS method has been applied in two different settings. First, it was applied in the system development phases of the action research project OLD@HOME (Koch, Hägglund et al. 2004). This was where the method was originally developed. The second setting where the MdTS method was applied was in the VIHO - Efficient Computer Support in Care for the Elderly (Johansson and Sandblad 2006) project, although in this case only the holistic seminars were utilized. The VIHO project was a normative study, using a perspective of five years for envisioning future work practices for homecare. The working group in VIHO consisted of five ANs (three HHS and two ANs working in an elderly care centre), one homecare nurse, and four researchers; two HCI specialists; one expert in teamwork and organizations and one HI specialist. Focus was on the essential parts of the work practices in elderly homecare and on how they could be improved in the future. Thus, the holistic seminars (1-6) were sufficient to provide this information. The VIHO project did not seek to design new technology to support homecare, and the detailed seminars were therefore unnecessary. In comparison, the OLD@HOME project required the detailed seminars to create the necessary knowledge for an actual development of an ICT system supporting cooperative work. This detailed seminar work resulted in working prototypes that were based on use cases deriving from the detailed requirements specifications for each user group.
4.2.3 Findings - impact on staff

The presented method urged staff in cooperative care to reflect upon current and future work situations. Working together in the seminars, personnel were quick to realize their own part of the entire integrated work process and they gradually reached an improved understanding of how their work contributed to the optimized workflow.

New insights were triggered by for example the technical workshop. Moreover, the new insights inspired staff to consider both information content and presentation format, combining them into innovative solutions.

Interestingly, the thematic seminar series and the subsequent insights had positive results not only with respect to the design of the resulting information system. The thematic seminars also led to changed work processes, such as improved documentation procedures.

Iterative prototypes illustrating the proposed work scenarios were used as communication tools, and this ensured that all personnel shared a common picture of the new work practices, possible chain-reactions, and consequences for other professions.

While testing the prototypes, the staff also gained a clearer understanding of the relationships between their own documentation and that of the other care professionals. This provided incentives for the professionals involved to write notes more thoroughly, knowing that they were useful to, and read by, other professions.

Using the same technique, it was also mutually agreed which information is, or should be, available in different work situations, and for different staff, and how this information should be presented in an optimal cognitive-ergonomic way.

Furthermore, the developed prototypes clarified the complex, integrated work processes and the workflow in practice. The prototypes also provided integrated views of information from different feeder systems. This led to fruitful discussions in the inter-care professional seminars as participants discussed the intersections in their work. Jointly planned activities were accordingly displayed in overviews. This integration provided new ways to feed back information and to follow up performed work.

4.2.4 Findings - impact on development

A fundamental principle of the MdTS method is that knowledge acquired in different domains and brought together improves cooperation and creates holistically integrated results.

In this case, to elicit user needs the development team was assisted by HI specialists with a sound knowledge of work processes and other usability issues, here referred to as a Health Informatics and Usability (HI-U) specialists. The HI-U specialists played an important role, directly affecting the
final design of the product by mediating between different stakeholders and converting clinical and organizational needs into requirements specifications for system implementation (figure 12). The HI-U specialists also worked with the users to validate the requirements specification against the user needs. More specifically, this means the HI-U iteratively explored the mutual impact on work environment and the proposed design and vice versa.

By using HI-U specialists as mediators between users and developers, the user needs analysis and the early development phases smoothly merged, and the traditional requirements specification was not necessary. Instead, users’ future work scenarios and prototypes were directly documented in use cases as technical specifications for implementation. This was a key reason why our industrial collaborators adopted this method. It is now being used in other industrial development projects.

4.2.5 Conclusions
This method was specifically developed for cooperative work. Application of the MdTS method demands working groups containing clinical domain experts and HI-U specialists. To develop a system that supports cooperation and sharing of patient information between different care professions, both the holistic and the detailed sections of the MdTS were needed. For other purposes, such as activity and information needs analyses or normative studies, application of the holistic part is sufficient.

Nevertheless, although engagement of clinical domain experts is mandatory, it is not always easy to achieve. Early contracting of replacement staff is recommended.

Our study demonstrated that a collaborative design method was needed to gain insight into the entire work process. Although user needs acquisition can be time-consuming, MdTS was perceived to efficiently identify in-
context user needs, and transformed these needs directly into requirements specifications. This transition of user needs to a system specification was facilitated by iteratively refined prototypes that were validated by the users in parallel with development of use cases. The use case work was performed by the HI-U specialists as part of the system specification. Consequently, the method was perceived to expedite the entire ICT implementation process.

In summary, the MdTS method was perceived to facilitate transfer of multiple user groups’ needs to system specification, thereby partly responding to research item 1 (in the Research Process, chapter 3). Further verification and validation of this research item could be handled only after implementation of the prototype.

4.2.6 Comparison with similar projects

Until a system has been developed that can be evaluated, it is difficult to confirm that the method’s resultant specified demands are indeed correct. To confirm the specified needs, researchers usually apply the method in another setting of the same kind. In this case, we sought to apply the MdTS method in two different homecare districts, and then compared the results. In cross-setting research, local differences may occur, but the overall results should be the same. When compared, the needs of the homecare participants involved in the VIHO project corresponded to the general demands and the specific and detailed needs regarding information and communication handling found in OLD@HOME (Scandurra, Hägglund et al. 2008).

Another way to confirm the results is to compare whether the demands found using one method correspond to those found in similar projects, using other methods. Both differences in methods and differences in settings may affect the results, but a comparison will still indicate any major flaws in the results.

I chose to investigate whether the demands we elicited, using the MdTS method in a specific homecare district, corresponded to demands gathered by other, similar, projects; Swedish homecare projects which used different methods and different homecare settings.

Projects3 with similar objectives as OLD@HOME were compared and

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3 The project reports are all in Swedish:


although original research questions, methodologies and results from the studied projects differed, on a general level the user needs specifications were broadly in accordance with the user needs in OLD@HOME. In particular, MobiSams and OLD@HOME had unintentionally validated each other’s methodologies. Although the research question in MobiSams (Winge, Johansson et al. 2007a; Winge, Johansson et al. 2007) looked at information modeling, and OLD@HOME’s research question regarded participatory and user centred development, both methods improved the care professionals’ patient care process and yielded similar detailed results with regard to needs and requirements.

4.3 Specific Demands in Shared Homecare (Paper II) and design solutions addressing the demands (Paper III)

Paper I elaborated on how to gather user needs and context requirements that support inter and intra-care professional work. Paper II describes the specific demands found when analyzing the complex work situations of shared homecare, in close cooperation with DNs, HHSs and GPs. In shared homecare, specific requirements can be attributed to mobile care. This includes, for example, ubiquitous access to information and cooperation between homecare professionals.

Paper III describes interaction and design solutions implemented in the VHR. These solutions are focused on addressing the specific demands of shared homecare, as they are described in paper II. The MdTS method resulted in scenarios for every mobile work situation and knowledge about the work activities to perform, today and in the future.

Before going into details of the needs and context requirements presented in Paper II, as well as the suggested design solutions from Paper III, I will further describe the prototyping strategies used to reach these results.

4.3.1 Prototyping

Iterative and incremental prototyping with high end user involvement was used in parallel with the scenario making. In the detailed thematic seminars, intra and inter-care professional working groups used prototypes as a means


for communication and for ensuring a common picture of new work practices supported by ICT.

Prototypes usually represent different design concepts and operate on different levels. Partial (horizontal or vertical) prototypes represent only a small part of the system, either the graphical layer or a specific function. Scenario prototypes are task oriented and involve a number of functions to carry out a scenario (figure 13).

![Diagram of Different features: Horizontal prototype, Scenario Prototype, Vertical Prototype, Full system]

Figure 13: Horizontal, vertical and scenario prototypes
(Modified from (Nielsen 1994a))

During the prototyping sessions, we used a combination of horizontal and scenario prototypes. The working groups first developed paper prototypes, consisting of design sketches of the user interface and storyboards to define required functionality. When digital interactive prototypes were provided, the scenarios could be followed in the system, and both the scenario and the prototyped solution were adjusted and refined. The multi-disciplinary discussions continued until an adequate level of refinement was reached. User feedback was thereby incorporated into the designs of the low fidelity (lo-fi) prototypes, and the developers understood the required functionality in the early stages of the design process. This functionality was later transferred to the high fidelity (hi-fi) prototypes via scenario descriptions and use cases.

The final system, although being a full (hi-fi) system, is still referred to as a prototype, as the product is not yet ready for sale on the consumer market.

The aim of this prototype system was two-fold, covering both methodological and socio-technical areas. The prototype’s methodological aim was to validate the context requirements and consequently the MdTS method applied to elicit those requirements. The prototype’s socio-technical aim was to demonstrate how ICT might enhance and improve work processes in a shared care context.
4.3.2 Results

I will here present both the identified needs of shared homecare, and the suggested design solutions to meet these needs.

The developed design solutions were tested on different hardware for different user groups in order to explore how to support each profession and their cooperating needs at the point of care (POC). A number of screen shots are used to visualize various design solutions.

Sharing of information

In order to support cooperation and coordination within a shared care team, it is crucial that all care professionals have access to the information they need in their mobile work environment, e.g. at POC. Information has to be integrated irrespective of organizational belonging. Sharing of information will improve not only information and communication flows but also affect the way care professionals document and deal with information.

An example of important ‘shared information’ is the patient’s prescription list. Medication is prescribed by the GP, monitored by the DN but often administered by the HHS. Thus, although the GP originally documented the medication, this information must be accessible to all of the personnel involved in the care of the patient. Our research showed that the availability of this information at the POC became additionally important in cases where the patient, or the patient’s family, were confused about the doses of medication.

Identifying origin of information

When care professionals are given access to information from feeder systems other than their own, it is crucial to identify who provided the available information so that users can interpret it correctly.

Color-coding was used to identify who provided the information. Information originating from the GP was always blue, from the DN it was yellow and HHS’ documentation was green (figure 14, 15).
Profession-based presentation of information

The kind of information needed at the POC and the optimal way of presenting it differs between care professions. Information from one feeder system should be displayed differently for different user groups. Some information is crucial to all care providers and can be identified as a common information need, but inevitably each profession also has specific needs. Attention should be placed on how the user groups differ from each other, since they have similar, yet distinct needs.

Not all information that can be made available is necessary to access for all healthcare professionals at POC. Information was therefore filtered to the needs of a specific profession and/or a specific work situation. Again, an example of a profession-based display was the prescription list. Specific information from the GP’s record was filtered and only parts that were essential to the HHS were displayed in their view. This included medical information such as name of the prescribed drug, preparation, dosage and strength. Clarifying notes, adapted to the need of HHS, were provided by the DN (Figure 15). The GPs and DNs on the other hand, needed access to a more complete, traditional prescription list; consequently, their views were conventionally designed (figure 16). In short, the filtered information application ensured that all the information required was available at the POC, to the personnel who required it, without creating information overload.
Figure 16: Conventionally designed prescription list for GPs and DNs.

Avoiding information overload

Giving users access to integrated information increases the risk of cognitive information overload. The balance between having all the necessary information readily available whilst avoiding cognitive information overload is important and can be examined through iterative user testing.

Usage of mobile devices at, or on the way to, the POC depends on complete and accurate display of information to prevent misunderstandings. Attention and consideration must therefore be given to optimizing the user interface to ensure that it presents information in a format suitable for the individual user in a certain work situation.

In addition to the filtering according to profession-based information access described above, and reduction of information to include only data necessary at POC, focus was also on interaction design. In the VHR interaction was facilitated through a logical information structure, i.e. a three level architecture (Figure 17). Tabs were used as entry points; each tab indicated a specific work task and consistently contained an overview, a detailed view and, where applicable, a writing mode. This was identical for both platforms (the PDA and the tablet PC) since similar situations for the users required consistent sequences of actions.

Figure 17: Logical levels consistently appearing in the VHR.
Supporting documentation

When a DN was writing a new note or updating the care plan, recently added documentation was available in the same view. This reduced the cognitive load, as there was no need to remember what was written before (figure 18). The user was able to choose whether to display the latest note or all documentation regarding the current keyword. Such visualization also supported novice nurses by providing examples of how to document a certain measure.

A similar design was made for HHS. When documenting a measure performed according to the care plan, they were provided with “standard documentation” alternatives in the same view in addition to the care plan.

Figure 18: Writing mode for DN to the right. Support by a selection either of previous notes or of current keyword is available on the left.

Quick overview of aggregated information

When accessing information from different care providers, there is a tendency to fragment the view to show information only from one care profession at a time. However, I believe that certain services e.g. care plans and patient summaries containing ongoing medication, risk factors and latest progress notes should preferably be presented in an overview that provides an easily accessible and holistic view of the patient’s health.

Risk factors, for example, were jointly presented (figure 14 and figure 19) to provide a holistic view of the patient’s risks. This information was considered important and was consequently easily accessible. In the DN’s and GP’s web applications, the risk factors were placed at the top of the screen, as they are crucial information. A regular staff member who knows the patient well may not need to see the risk factors all the time. Therefore, the users were given the option of not displaying the information, thereby being
able to utilize more space for other information. By clicking on the icon, the risk factor field was minimized (as in picture 18, where only the icon is visible next to the patient’s name at the top of the screen).

Figure 19: Risk factors on the web, an example of simultaneous presentation of aggregated information, which is color-coded according to the original owners.

Pre-defined compilations of keywords in specific views were also designed. Aggregations of the most recent notes documented under the keywords “patient status” and “patient history” in the GP’s and the DN’s views were considered a success. Aggregations of the latest documentation from all care professionals’ daily notes and aggregations in the integrated care plan were also displayed in holistic views. Keywords were easily distinguishable in these aggregations by the use of bold lettering (figure 20).

Notification of new information
When patient care is shared, a major challenge is keeping up to date with constantly added new documentation. A means of notifying staff that new documentation exists is important.

Highlighting of unread documentation (figure 20) provided immediate notification of updates.

Figure 20: The DN’s care plan: aggregated information where activities to perform by either HHS or DN are highlighted.

High priority messaging
A high priority messaging system is another requirement, to enable immediate communication to other care professionals. Such a system should be able
to signify high importance as well as ensure that the message is received and read by relevant personnel. This was not part of the VHR developed in OLD@HOME.

**Taking the user’s knowledge of a patient into consideration**

Even if individual views for every care professional are not implemented, it should at least be possible to individualize on a user group level. As an example, regular staff usually requires a different view to temporary staff, as the latter have no personal knowledge of the patient. Thus, the temporary staff’s view should provide patient information that is more detailed.

**Work coordination and planning**

Coordination of care for chronically ill patients places large demands on the information processing capacity within and between the care provider organizations. Currently, paper-based care planning is usually used for allocating tasks to professionals from different disciplines. In this context, the teamwork (e.g. planning, performing and follow-up) could be considerably improved if it is coordinated and reviewed with support of (usable) ICT. Therefore, DN’s and HHS’ individual care plans for elderly (Figure 20), were designed to enhance integration of different care practices into the collaborative work process. There was also a demand for keeping track of jointly planned activities. In this design, a holistic view of the cooperative process was achieved and accessible at POC. The interaction structure was based on the logical levels (figure 17) in order to clarify the work process of planning and performing measures according to the care plan. Compared to the previous paper-based care plan, which was not available at POC, this integrated POC care plan also worked as a reminder to perform and evaluate measures, thereby improving the entire work process and the care provided.

4.3.3 Conclusions

I assumed the developed MdTS would result in a description of agreed system context requirements (research item 2, in the Research Process, chapter 3)

For the future development of a system supporting multiple users collaborating in a complex work environment, it was important that all users agreed on the purposes and objectives regarding the development of the system. They also needed to agree on which of the users’ needs and context requirements were to be supported by the ICT system.

The results emanating from the MdTS method included not only the individual needs from each profession. More importantly, vital information in the points of intersection between different care professions was elicited and a holistic view of the entire care process was obtained. This made it possible to agree on the description of the system requirements, particularly those
requirements relevant to all professions. Some of the specific demands required from all homecare professionals were:

- an easy accessible and holistic view of the patient’s health,
- notification of new information and
- high priority messaging between the professionals.

The list of specific demands presented in paper II is a good starting point for the development of any ICT system with shared information in integrated care. Some of the demands described above are not specific to shared homecare but important to other areas of primary and secondary care. Inevitably, the ability to quickly and easily access relevant patient information at the POC, the flexibility to configure the presentation to one’s personal preferences and the ability to quickly and reliably deliver messages to other team members is of importance and relevance to all healthcare professionals.

However, the optimal way of presenting this information differed between the care professions in the study. The demands often seemed to be identical or similar, but when analyzed in detail they differed distinctly. Both profession-based and context-dependent interfaces were therefore required.

Validations of the needs and verifications of the system requirements were performed to examine whether the MdTS method facilitated the transfer of multiple user groups’ needs to system specification (research item 1 in the Research Process, chapter 3).

In summary, the developed system showed that sharing of patient information and documentation as well as communication at the POC was feasible (system verification). When the demands were validated by the users, they further demonstrated that appropriate ICT for shared homecare assist care professionals in better understanding of the specific work of their colleagues (figure 21).

A tool that does not take these demands into consideration risks creating confusion and an increased cognitive load for users, instead of producing increased cooperation within the work team and in the end a higher quality care.
Only with deliberate attention to the context, we can improve the ways in which ICT contributes to the efficiency and effectiveness of health-care professionals. Consequently, these design solutions helped to validate use of mobile devices in homecare. Simultaneously the requirements specification was verified as the prototype corresponded to the specific demands as posed by the personnel in shared homecare. Research item 2, the description of the agreed (system) context requirements was accordingly validated, considered fulfilled and agreed on when the users tested the prototypes.

4.4 Usability evaluations (Paper IV and Paper V)

One of the advantages of applied research is that it is goal oriented and (typically) results in a tangible product, which can be evaluated. The MdTS method contained a validating and verifying process, which was used to test if, and to what extent, the system meets its goals. In this process, all stakeholders involved repeatedly evaluated the system against initial objectives, needs and requirements. When the system was deployed, the VIHO working group validated the method and verified the results from the thematic seminars. Some VIHO participants also tested the prototypes. Moreover, qualitative evaluations based on patient and staff experiences of the prototypes have also been performed at the OLD@HOME test site. To date not all the results from these continuous evaluations have been published.

Iterative testing was further conducted midway through the development cycle and sought to provide iterative feedback on the evolving design of the systems prototypes (Kushniruk and Patel 2004).

The heuristic evaluation presented in paper IV was performed prior to testing in a real user environment. The usability lab evaluation was performed after the system was actually tested in the real environment. This usability lab evaluation involved personnel from another homecare district who were unfamiliar with the system.

4.4.1 The Heuristic Evaluation (Paper IV)

Paper IV describes a formative assessment of the full system version of the prototype, with focus on the presentation of integrated information to support cooperative work. Emphasis was on the user interface, but the conventional evaluation method (as explained by (Nielsen 1994)) was extended to include the potential work process of the intended professionals. This was achieved by applying a “potential user analysis”.

Potential user analysis

In user centred development, it is crucial to find out who the users are, and their characteristics. Both real and potential users must be identified. In our
study, a context of use questionnaire was used (Maguire October 2001) to capture potential users’ tasks, motives and goals as well as their domain, their tools, and their differing work situations (figure 22).

In this evaluation, the potential user groups were analysed by so-called double experts; that is informaticians with experience from healthcare.

Two categories of district nurses were identified as potential users and given special consideration during the heuristic walkthrough of the web application. Both groups had extensive domain knowledge and knowledge about the patients belonging to their district. One group consisted of experienced, frequent users of the system, whilst the other group contained novice users, who were not particularly skilled in computer technology.

**Heuristic inspection results**

The evaluation included a comprehensive description of the problem, details of the place of occurrence, the heuristics violated, specific user considerations and severity ratings.

The evaluators categorized 58 heuristic violations for 44 identified usability problems, originating from ten heuristics (Nielsen 1994). As a single usability problem can be a violation of multiple heuristics, the number of heuristic violations is higher than the number of identified usability problems. The nature of the usability violations was analysed. Figure 23 illustrates the categorisation of identified heuristic violations and their frequency (n=58).
Among the ten heuristics used, “Consistency and Standards” and “Flexibility and efficiency of use” were the most frequently violated heuristics and accounted for 46 percent of all the identified violations. The problems identified were further classified according to the kind of users predicted to undergo the violation. With respect to “Consistency and Standards”, the majority of the violations would probably disturb both novice and experienced users. This heuristic was also predicted to create the single largest potential usability problem for novice users.

For each heuristic, an average of the severity ratings was calculated. Based on the scale of 1 (cosmetic) to 4 (catastrophic) the average severity ratings of all heuristic violations identified in the prototype was 1.78.

The “Flexibility and efficiency of use” was categorized as less frequent to novice users, but 10 of 13 violations (77 percent) were considered to have potential negative impact on experienced users. The most severe violations were identified in “Visibility of system status”, with an average on 2.67 (3: major usability problem = important to redesign).
4.4.2 Conclusion

Use of Heuristic Evaluations in combination with user analysis during system development of HIS provided results adjusted to the future users of the system. This evaluated application was used by district nurses and the results of the “potential user analysis” were given special consideration during the heuristic walkthrough.

All of the violations that were rated as major (major = 11 of 58 violations, 19%) would create a potential problem for novice users and should be given high priority in the redesign. Examples of often violated heuristics were “Consistency and Standards” and “Visibility of system status”. Other problems were identified to create potential negative impact on experienced users, e.g. “Flexibility and efficiency of use”. Those were mainly rated as minor problems.

The adding of a potential user analysis to the conventional heuristic evaluation was new. It was considered an efficient method to identify potential usability problems in shared homecare where heterogeneous user groups are common.

The reported usability problems corresponded to the assumption made in research item 3 (in the Research Process, chapter 3): a low degree of usabil-
ity problems. In total, relatively few problems were detected (n=44), but more importantly, in the severity ratings, none of them was categorized as catastrophic; the majority consisted of cosmetic or minor problems. Few of the potential usability problems detected (11 violations counted in 7 problems) were imperative to adjust.

4.4.3 The usability lab study (Paper V)

One of my research assumptions was that the developed VHR could be transferred to a different homecare setting, and that novice users such as substitutes or new recruits, would be able to use the system with limited introduction and/or education.

The purpose of this study was therefore to investigate the usability of the VHR system when used by specific users in a specific context. In this case specific users were identified as first-time users from a home help service (HHS) group and the specific context was when newly introduced to the system (Dumas 1999). More specifically, the purpose of the usability lab study was:

- To evaluate the effectiveness for relevant and frequent tasks for the participants (HHS personnel) when performing their daily work,
- Where effectiveness was low, identify potential usability problems, to improve the design and,
- To obtain subjective user satisfaction measures of the VHR.

To reflect a realistic situation in homecare, specific test profiles were identified, and the participants were asked to perform a series of tasks related to their daily work. Eight participants were recruited to test the VHR on a handheld device, a PDA. They came from a homecare district different from where the VHR was developed. The participants were all experienced homecare staff, and according to the test profile of first-time users, they had no prior knowledge of the patient or the system, except for a limited period of education.

Their introduction to the system was similar to the one a substitute in a homecare district would undergo. Usually, an introduction to homecare work consists of two days of apprenticeship where specific tools like an ICT system could occupy approximately two hours. The education was given by experienced users from the homecare team of the VHR test site.

The day a new recruit starts working, a colleague gives a short demonstration of how to handle the ICT tool. Thus, to mirror this situation, the participant received a similar system walk-through from one of the test managers prior to the test.

Each participant test was recorded in several ways. Interaction on the PDA screen was digitally recorded as well as the physical interactions when the participant was working with the PDA (figure 25).
This study explored how effective a new mobile healthcare application was for experienced homecare staff based on their performance of daily activities. The activities were grouped in test tasks (table 1) according to goals in daily homecare work: (I) HHS need to be able to find practical information, (II) HHS need to be able to find health-related information, (III) HHS need to be able to document new information.

Table 1: Task scenarios covering each goal

<table>
<thead>
<tr>
<th>Goal</th>
<th>Task</th>
<th>Task scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>You have never visited Werner Wikman before so you have to find his address.</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
<td>What is the latest thing written in the daily notes?</td>
</tr>
<tr>
<td>II</td>
<td>3</td>
<td>You have never visited Werner Wikman before, so you do not know much about him. You want to find out if he has any special health problems. Is he allergic to anything?</td>
</tr>
<tr>
<td>II</td>
<td>4</td>
<td>When you arrive at Werner’s home, he persists that he should have his house cleaned today, Thursday. You get confused, since no one has mentioned this to you earlier. Therefore, you look up information about Werner’s services in the care contract.</td>
</tr>
<tr>
<td>II</td>
<td>5</td>
<td>Find out what goals Werner has described in his care plan.</td>
</tr>
<tr>
<td>III</td>
<td>6</td>
<td>Now you are finished at Werner’s home and you need to document the performed measures according to the care plan of the HHS. Use the fastest way to document that Werner got out of bed in time this morning.</td>
</tr>
<tr>
<td>III</td>
<td>7</td>
<td>You should also document that Werner had a shower today, but he did not want to wash his hair.</td>
</tr>
<tr>
<td>II</td>
<td>8</td>
<td>Now you wish to find your last note in the list of daily notes.</td>
</tr>
<tr>
<td>N</td>
<td>9</td>
<td>Arne Andersson has triggered his safety alarm, so you quickly head for his home. On the way, you change patient in the VHR. Open Arne Andersson’s file by clicking on his name in the name list.</td>
</tr>
</tbody>
</table>
| I    | 10   | At Arne’s home, you understand that he has fallen and hurt his
hip. He is in pain and you want to contact the district nurse who is responsible for Arne. Who is the responsible nurse? What is her phone number?

III  11 When you finished talking to the nurse, you have agreed on sending Arne to the hospital. When everything has settled you write a note about the alarm and the actions you have taken.

N   12 You are on your way to Stig Larsson to help him take his (prescribed) medications. Open Stig’s file in the VHR.

II  13 Find Stig Larsson’s list of prescriptions (prescribed medications).

II  14 Find out when the medicine Seloken Zok should be taken.

Usability lab results and analysis
In this tentative study, participants were not randomly selected from the intended user population. Thus, using statistical procedures to estimate population characteristics in terms of the effectiveness of the VHR was not meaningful. However, great care was taken to recruit participants that were realistically representative of the intended system users. Therefore, there is some ground to claim that the results generated are important indicators of possible problems with the effectiveness of the system.

The analysis was based on the main activity goals of homecare and focused on system usability factors such as effectiveness and user satisfaction. Since assessment of time was an important factor in this study, task effectiveness was defined by the usual time taken by an expert user to complete the task. The expert user task-time was multiplied by three and this total became the maximum time allowed for the novice users to complete the task.

Figure 26: Task effectiveness (failure and completion) grouped according to different work activities; finding practical information, finding health-related information, documentation of new information and navigational issues. (Due to an unexpected task flow, task 7, 8, 11 measure only 7 participants.)
Regarding Effectiveness

Seven of 14 tasks were completed without failure by all participants (figure 26). Of the remaining seven tasks, 20 failures in 109 trials (18.35 percent) were noted.

The main problems were caused when documenting new information (goal III) in three specific tasks (10 failures in 22 trials). One task (task 6) was extremely problematic. Only one participant succeeded in completing the task, three participants responded incorrectly according to the test plan and four participants failed due to the time constraint (>180 seconds). Another task (task 7) caused problems for three of seven participants. Two of these failures were a result of erroneous answers. These tasks were obviously considered “not effective”, and a new design for the documenting mode was prepared.

Finding health-related information (goal I) was performed in seven tasks and six failures in 55 trials (10.91 percent) were noted. Four failures in 16 trials of two tasks relating to finding practical information (goal II) were also noted.

A task was considered effective when six of eight participants completed the task. Three tasks (of 9) regarding finding information (tasks 10, 4, 8) were considered not effective and need further exploration.

Regarding potential usability problems

Task completion time was different for different tasks. Mean times of tasks that related to writing new information were approximately two minutes, while mean times of tasks relating to health-related information searching were between 20 and 40 seconds. A majority of the participants completed six of the tasks regarding finding information in less than 30 seconds. This was as quick as the expert users.

Where the participants deviated from the pre-defined most direct route in achieving the task goal, we noted a potential usability problem and analyzed why the participant was unproductive. Methodological framework for the analysis of potential usability problems was Nielsen’s ten usability heuristics (Nielsen 1994). The problems found violated a number of the heuristic rules including “match between system and real world”, “consistency and standards”, and “error prevention”. The identified potential usability problems need to be adjusted to prevent users from committing those mistakes in daily work.

Regarding user satisfaction

To triangulate the results from the measurements, the post-test questionnaire (table 2) also captured opinions regarding the homecare goals and their fulfillment. This included analysis of how easily users found practical or health-related information in the system, and how easily they documented
new notes. By adding values to the 5-point Likert scale (higher scores correspond to a more desirable state) group median values (GMV) could be calculated in order to summarize the subjective opinions in a quantitative and objective analysis.

Table 2: Statements used in a Likert User Satisfaction Questionnaire

<table>
<thead>
<tr>
<th>User satisfaction questionnaire: Opinions of the VHR and the tool.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regarding today’s short demonstration:</td>
</tr>
<tr>
<td>1. Today’s demonstration covered my needs to be able to perform this test.</td>
</tr>
<tr>
<td>2. A demonstration is important before I start using this tool in homecare.</td>
</tr>
<tr>
<td>Experiences of the ICT tool:</td>
</tr>
<tr>
<td>3. It took a long time to find practical information about the patient.</td>
</tr>
<tr>
<td>Example: Where does Werner live?</td>
</tr>
<tr>
<td>4. It took a long time to find health-related information.</td>
</tr>
<tr>
<td>Example: When does Stig Larsson take Seloken Zoc?</td>
</tr>
<tr>
<td>5. It took a long time to document new information.</td>
</tr>
<tr>
<td>Example: Document that Werner got out of bed in time this morning</td>
</tr>
<tr>
<td>6. I experience that technical tools can enhance my work.</td>
</tr>
<tr>
<td>Regarding finding/understanding information:</td>
</tr>
<tr>
<td>7. Following menus and tabs I easily found what I needed in the application.</td>
</tr>
<tr>
<td>8. The tabs were easy to understand.</td>
</tr>
<tr>
<td>9. I understood that the arrows to the right meant that there were more tabs to find.</td>
</tr>
<tr>
<td>10. The icons (examples: Warning and Who is logged on) in the menu were easy to find.</td>
</tr>
<tr>
<td>Regarding the over all impression of this tool:</td>
</tr>
<tr>
<td>11. It was easy to enter new information.</td>
</tr>
<tr>
<td>12. It was easy to learn the new system.</td>
</tr>
<tr>
<td>13. My work would be enhanced if I had this kind of tool.</td>
</tr>
</tbody>
</table>

The participants rated the perceived time to find health-related information as shorter than to find practical information. These opinions were in line with the usability measurements.

“Following menus and tabs, I easily found what I needed in the application” [GMV=3] was contrasted by the responses to the statement “The tabs were easy to understand” [GMV=4]. I interpreted this, triangulated with the additional comments from the users, as the participants preferred working with the tabs. On the other hand, icons on the menu seemed to be easy to understand [GMV=4]. Responses to system navigation components (menus, tabs, icons and arrows) varied from a GMV of 3 to 5, resulting in an overall positive rating of the user interface and its navigation.
The overall impression of the tool was positive and the system was (subjectively judged) to be easy to learn [GMVs=4]. The statement on entering new information assessed whether the tool (the PDA application and the stylus) was adequate for novice users. It resulted in a GMV of 4, which coincides with the observations made regarding the participants typing speed.

The last set of statements revealed changed opinions regarding use of ICT tools to enhance the homecare work. The pre-test questionnaire (after the education but before the test) showed a [GMV=4] on the statement I experience that technical tools can enhance my work. After testing the VHR the same statement now increased its GMV one point [GMV=5]. The statement my work would be enhanced if I had this kind of tool received an equally high GMV [5].

The participants’ experiences of the VHR in the laboratory setting can be summarized as it was not perceived to take a long time to find information in the system. However, visualization of how to navigate and find practical information need to be improved. Participants also perceived that writing new information took neither a long time, nor a short time. Consequently, we have noted that there is scope for improvement in this area.

4.4.4 Conclusion

As we can note, usability evaluations, especially in the usability lab, are not only research experiments. They can be performed to test hypothesis and support theories; they can also be used to refine user interfaces rapidly. Shneiderman (Shneiderman 1998) (page 128) explains: “Both strategies use a carefully prepared set of tasks, but usability tests have fewer subjects, and the outcome is a report with recommended changes, as opposed to validation or rejection of hypotheses.” The outcome of this assessment was mainly intended to establish the foundation for further work on the development project. Therefore we could perform the test with relatively few participants (n=8).

The objective was to evaluate the effectiveness of the VHR for relevant and frequent tasks for new homecare personnel. Specifically, I tried to find out whether new homecare staff was able to use the system with a limited amount of introduction (research item 4 in the Research Process, chapter 3).

The results of this study were:

(1) The discovery of potential usability problems that should be eliminated before the system is used routinely,

(2a) Contextual differences, such as terminology use and documentation practices also affected the test results. Consequently,

(2b) If left without consideration, these issues could consequently hamper the work of a different homecare district, should the VHR be implemented in that region.
(3) The analysis also revealed that the participants were overall satisfied with the application.

Despite this study, it is clear that further investigation in a full-scale usability test is needed to elucidate the effectiveness failures and potential usability problems with respect to a larger population. In addition, observation studies have to be performed to capture contextual differences in other homecare districts where the system is to be implemented.
5 Discussion and conclusions

Nothing is more dangerous than an idea when it is the only one we have.
Emile Auguste Chartier, (1868-1951)

5.1 Bridging the gap

There is a lack of usable ICT systems in healthcare, especially when it comes to information systems for cooperative care (Koch 2006). It has also been recognised that one of the key problems in this context is the knowledge and communication gap between users and developers. Healthcare professionals are often unaware of the possibilities of technology and system developers are not knowledgeable enough when it comes to the specific needs of healthcare users. This problem is augmented in cooperative care, as different categories of healthcare professionals have different needs, all of which need to be incorporated into the ICT system.

The work described in this thesis aims at finding ways to combine methods and knowledge from two different research disciplines, health informatics (HI) and human-computer interaction (HCI) to develop usable and work process-oriented systems for cooperative care. In this chapter, I will discuss my research objectives in relation to:

- the research methods used, and
- my research results (MdTS method, design solutions, usability evaluations).

5.1.1 Methodological discussions

My goal within this action research project has been to examine whether the needs and context requirements defined by the users, were interpreted and transferred correctly to the development process.

The main contribution of this research was the process involved in developing and validating our results. Compared to many other studies, we actually developed a system, directly applying the proposed methods in shared homecare. The stepwise process of verifying the results after each step, from
user needs elicitation to triangulated usability evaluations, was a way to control the development process further.

When new methods are applied, they reveal situations where new problems may arise. An important step in comprehensive research is to investigate further or follow-up on these new issues. Moreover, it is then important that the findings of the further research are also disseminated. This process allows the field of research to move forward. In OLD@HOME, the daily notes case provides a good example of an evolving new problem, and how our research was adapted to meet this new demand. When the staff discussed daily notes, they were visioning how they interchanged the “perfect daily note” from different professions. Later, when they started to actually share their daily notes, they discovered that their actual documentation procedures needed to improve in order for other professions to understand what was written. To respond to this new demand, a student from caring sciences was engaged to compare daily notes before and after system implementation.

Further, when the system was deployed in a real homecare setting, assessments of how users actually interacted with integrated health information provided useful insights for future design (and/or re-design) of ICT systems. This understanding was beneficial for future homecare applications, as well as for other (healthcare) domains where work is intricately integrated between different professions.

5.1.2 Discussion of the MdTS method

As an initial phase of the user centred design process, the MdTS method was developed to answer the question: How to elicit user needs and context requirements that support inter- and intra professional work?

The answers to this question are thoroughly discussed in this thesis, in the sections which correspond to the findings of paper I. In short, participatory design was used in inter-professional seminars to inspire the users to improve their own conditions of work. The development of a new cooperative ICT tool will ultimately alter how the actual work is performed. Thus, the users should be involved in the process, and in this way be given the opportunity to shape how their own work is altered. Development of the new ICT system in tandem with new work processes gives two-folded results. As new work processes are developed, support from the users improves the new ICT system, which mutually increases the usability, effectiveness and work integration of the new ICT system and the work practice.

Communication between the professions involved in the development process, developers and care professionals, is extremely important in order to identify exactly how, when and where ICT can support work practices. However, different professions use different languages and the complexity of work practices or the constraints in technology are difficult to explain and to mutually understand. Therefore, I advocate the role of HI-U specialists
with bridging skills from both domains. The HI-U role assists in communi-
cation, promotes users and usability while maintaining an understanding of
the limitations and potential possibilities of the technology on hand. More
specifically, the HI-U specialist iteratively explores how work environments
can affect the use and reliability of the proposed design and vice versa. In
order to elicit the multiple users’ needs in natural language, and transform
them into system requirements in the form of use cases, a structured method
such as MdTS is mandatory.

Although I propose a process for improved system development for
shared homecare, at this stage, it is impossible to evaluate whether the user
centred design process we applied is better or faster than other development
processes. We do not have sufficient resources to develop a multitude of
systems for home healthcare according to different methodologies, only to
compare the development processes. Moreover, this was not the question
which this thesis set out to answer. As a result of this, at this stage, it is not
possible to conclusively prove whether factors, such as time spent in our
development process was less than in conventional system development
methods. Regarding the time expenditure, however, experienced project
members participating in this action research project perceived time spent as
less or equal to other “standard” development projects. They argued that the
longer amount of time taken to thoroughly elicit user needs and requirements
was made up for when the system implementation process was initiated.
That is, due to the early start of iterative prototyping, at this stage there was
immediate transition of requirements and fewer coding errors.

5.1.3 Discussion of the design solutions

Prior to design of mobile applications in homecare, the question: “What are
the specific and new demands in shared homecare?” requires an answer.
Paper II provides the specification of demands elicited during the MdTS,
and paper III presents the design solutions.

This is an important study since mobility of people and their technologies
have not been investigated in much detail within the field of computer sup-
ported cooperative work (CSCW) (Weilenmann 2003). Use of mobile de-
vices has mostly been adopted into work within one specific profession (Luff
and Heath 1998). Thus, design solutions for mobile applications supporting
inter-professional work (paper III) led to another question: How can design
solutions be adapted to different user groups? Each solution was carefully
designed to support both the individual work performed by each profession
and to strengthen the collaborative parts. The resultant design was an ICT
tool that allowed for different views of the system, applied on different de-
vices for the variety of professions.

As this thesis is concerned with the design for adaptation of ICT systems
into work practices, system usability is of utmost importance. Therefore, the
developed systems emanating from the MdTS method needed to be thoroughly evaluated.

5.1.4 Discussion of the usability evaluations

The applied evaluation methods (in paper IV and V) intended to approach validation of the user centred design process by verifying the new ICT system (paper III), based on the requirements specification (paper II) identified using the MdTS method (paper I).

My research question “How can we combine methods and knowledge from HCI and HI in order to develop usable and work process-oriented systems for homecare?” was therefore partly answered by the development of the MdTS method supporting the user centred design process.

To only develop a method is however not sufficient. A method requires validation. The research question was therefore refined to include a comparison with conventional system development methods. Again, this is not possible to fully answer. Nevertheless, my research has started the process of testing this assumption and some answers have been brought forth.

According to my experience and understanding, a system, iteratively verified against the requirements and validated by the users during development, should already be usable and contain information and interaction designs that actually support work. However, these tests mainly control whether the goals were reached (verification), not whether they were the right goals. By applying usability evaluations, validation of the right goals was further approved.

The combination of one analytical evaluation, the Heuristic inspection (paper IV), and one empirical evaluation, the usability laboratory study (paper V) was fruitful. When used together they produce more valid results than either evaluation used alone (Fu, Salvendy et al. 2002; Lathan, Sebrechts et al. 1999; Law and Hvannberg 2002).

In this case, both evaluations were designed as constructive assessments and consequently designed to focus on finding potential usability problems during development. However, each evaluation method also contributed information on how the system was perceived.

Great care was taken to recruit participants to the tests that were, in all important aspects, representative of the intended users of the system. Three of the six inspectors who assessed the VHR view for nurses (paper IV) had extensive experience from nursing care. All eight participants that performed the usability lab test were HHS personnel, assessing the HHS part of the VHR. Therefore, there is some ground to claim that the results generated can be regarded as important indicators of both the expected benefit and of possible problems with the system for the intended users when used in routine daily work.
The evaluations are different in their characteristics. The inspectors provided unstructured comments in the evaluation report, whereas the users filled in a user satisfaction questionnaire with predefined choices and were briefly interviewed after the test.

Where applicable, the results were triangulated to answer questions regarding how integrated health information supported shared homecare work and how design solutions were adapted to mobile situations for different user groups. Information gathered from multiple healthcare systems was displayed in different views supporting each care profession involved in the cooperative work at stake. Sometimes information from different feeder systems was integrated in the same screen (c.f. paper III).

Another question supporting the research objectives, and finding its answers in the evaluations (c.f. paper IV and paper V), was how can this integrated information support cooperation and coordination of work for different professions in a shared care team? Apart from potential usability problems and proposals to improve the design, the heuristic evaluation only provided some information to correlate with the user satisfaction questionnaire. Both evaluations commended color coding, making it possible to identify which profession supplied the information. The color consistency throughout the system was also mentioned. It was perceived to prevent misunderstandings in reading and interpreting information in the system.

The use of tabs as holders of information was overall positive. The inspectors commented that the system was easy to navigate without being forced to go back if a wrong itinerary was chosen. Moreover, while using the system, the tabs allowed users to feel in control.

The virtual care plan was considered, by the inspectors (paper IV), to be one of the best design solutions, whereas the HHS team (paper V) did not favour that design particularly. The participants in the usability lab were unaccustomed to using a care plan and therefore had trouble grasping the full meaning of this concept. On the other hand, they found the prescription list, provided by the GP with additional notes from the DN to be a very valuable tool.

A general problem in the design of usable interfaces concerns how a large and complex information structure can be visualised and controlled efficiently on a relatively small screen. The design solutions on the PDA illustrate that work-situation dependant views are effective also on small screens. Novice users were, for example, almost equally fast as expert users in finding information.

Analyzing the heuristic evaluation, I interpret an absence of catastrophic usability problems, and a relatively low level of major problems to be regarded as fulfilling the requirements and consequently a step forward in validation of the MdTS method.

Regarding occurrence of severe violations, the results in this study are in line with other heuristic evaluations conducted on medical applications or
devices (Graham, Kubose et al. 2004; Tang, Zhang et al. 2006; Zhang, Johnson et al. 2003) (Allen, Patel et al. 2005; Lathan, Sebrechts et al. 1999). The persistence of certain violations (“consistency and standards”, “flexibility and efficiency of use” and “visibility of system status”) indicates that those heuristics are difficult to design for and that development of ICT in health-care ought to consider these usability design principles more carefully. However, in the present evaluations few violations were considered severe.

Analysis of the user satisfaction questionnaires revealed that the participants’ opinions regarding use of ICT tools to enhance the homecare work changed after using the PDA in the test. The same statement increased its group median value of one point, from four in the pre-test questionnaire to five after the test (group mean value 3.75 to 4.625). (c.f. paper V). The statement regarding my work would be enhanced if I had this kind of tool received an equally high group median value, five (group mean value=4.625). The test participants were overall satisfied with the tool and the application as such.

Since daily use of the VHR in the homecare district where the system was tested worked seamlessly, the prototypes appear to be usable and I will continue to evaluate the MdTS method and its results. Ultimately, knowledge of how well or how poorly designed a user interface actually is, cannot be widely known until it is in daily operation in real care settings (Graham, Kubose et al. 2004). Although at this stage the ICT tool (and the development method) appears to be highly successfully, I consider that only after some years of routine work, the efficiency goals in the OLD@HOME project can be assessed.

For estimations of transferability and potential generalizability, further evaluations of the implemented designs are needed.

5.1.5 Conclusions
An overall positive impression was gained from the results from the usability evaluations, in conjunction with qualitative analyses from interviews after the users had worked with this application. However, the results also indicate that it is difficult to transfer the results from one healthcare setting to another due to differences in operational routines. This further sustains the value of participatory design; each work practice needs to define its own problems and solutions in order to help develop usable and work process-oriented ICT support.

Thus, in this study, the information needed at point of care was available to the users and presented in an understandable manner. Consequently, the MdTS method succeeded in elicitation of the correct user needs and in transferring the correct requirements specifications to the system developers.
6 Contributions

*In creating tools we are designing new conversations and connections.*
(Winograd and Flores 1986)

6.1 Relevance to research

The community of people who are actively applying usability in development of ICT systems is expanding, and this phenomenon is also seen in healthcare. The design of usable healthcare ICT systems requires interdisciplinary approaches, bringing people together from different healthcare professions, from different technical specialities and from different social and cultural contexts. To exploit these diverse competences in an optimal way, we need structured methods for cooperative design. In this context, my PhD thesis contributes with a structured method for the early phases of a user centred design process. The method was validated by evaluating the usability of a resultant, newly developed homecare ICT system.

Inspired by Prof. Alistair Sutcliffe at the doctoral consortium of Interact 2005, I consider that one’s research should be explainable in one sentence:

“My PhD will **improve** the work environment for **homecare professionals** by providing methods and tools to develop ICT support systems for daily homecare activities, and at this stage I can partly **prove** this through **assessments performed using a usability inspection method and a usability lab test where the intended users tested the developed homecare ICT system.**”

“What was already known before my PhD?”

- HCI research methods support user centricity and cooperative work for development of work-process oriented ICT systems.
- There is a lack of usable ICT systems in healthcare and we know that user-centred design results in more usable ICT systems.
- It is difficult to transfer insight and understanding from work analyses into technical specifications for system development.
- Usability evaluations are to some extent used in healthcare. Usability is, however, seldom incorporated into the early phases of system design.
6.2 Contributions to the non-academic world

Action research has a direct impact on the study setting. Regarding the case study forming the foundation for this thesis, the OLD@HOME project, the impact was manifold. The impact of the project on different staff categories, patients and relatives, industry and healthcare organisation are described more in detail in the final project report (Koch, Hägglund et al. 2005). However, I would like to emphasize a few factors of relevance that are directly related to the MdTS method presented in this thesis. These reflections are based on own experiences and qualitative studies, performed during and after the action project OLD@HOME.

1. Results from the MdTS were directly documented in use cases as technical specifications for implementation, which was perceived to expedite the entire ICT implementation process. As the method was also perceived to identify in-context user needs efficiently, and transformed these needs directly into requirements specifications, our industrial collaborators later on adopted this method. It is now being used in other industrial development projects.

2. The healthcare staff involved in the project not only perceived the resulting prototypes as useful and supportive working tools, they also gained improved insight in their own and their colleagues work. The inter-professional work resulted in an improved mutual understanding of the needs of all involved staff. More specifically, staff better understood how their own work should be performed in order to support continuity of care for the patient.
3. For the staff, participation in the MdTS brought many new experiences. They analysed their work practice, discussed advantages and disadvantages of different solutions, and worked with researchers and other healthcare professionals in a situation outside of their daily homecare work. Many stated that they underwent positive personal development and became quite positive about changes in their work. Finally, I hope that this thesis creates an understanding of what usability is and which usability methods are suitable in the development process, for evaluation, and when health information systems are purchased.

6.3 Lessons learned

To support inter-organizational communication and cooperation in homecare by means of ICT is difficult. Are we doing the right things in the right way? System developers approaching users in a new domain often experience initial difficulties when trying to understand what actually happens at work. Their knowledge of HCI is often limited, as is the time schedule for development. The start-up phase for ICT projects in healthcare is in great need of further support, thus use of the MdTS method is one possible way.

We approached the problem from a usability perspective without neglecting the technical approach needed to develop robust systems. Strengths from both architecture driven and usability driven approaches have been combined (Moström, Hägglund et al. 2006).

However, even if the resulting ICT system is accepted by the users, it is in no way a guarantee for its permanent implementation in daily practice. To guarantee deployment of ICT systems for cooperative care, collaboration must increase and goals and routines for inter-organizational cooperation need to be set-up. This includes collaboration among managers, at strategic and tactical levels, as well as collaboration among staff at the operational level.
Focus of this thesis was methods for development and evaluation of health information systems for shared homecare. Yet the work does not stop here. I will continue to build usability into integrated health applications. Plans for future work include:

- Visualization design for shared and aggregated health information
- Further evaluations to explore effectiveness, efficiency and user satisfaction of the VHR and other health information systems.

Detailed descriptions of the methods used and evaluation processes during implementation and deployment of the VHR are of interest for both HCI and HI research. How the design of future work practices shapes the results in a real setting would also be very interesting to explore and evaluate.

7.1 Visualization Design in Shared Care

When focusing on the specific demands of shared care, visualization and interaction design enhances the understanding of cooperating professionals’ need for information. Thereby different care practices receive visualized support in integrating their work into a collaborative work process.

Many specific design solutions are already implemented in the integrated VHR supporting cooperation and coordination in shared homecare for the elderly. User interfaces were adapted to different user groups with similar yet distinct needs and the solutions were modified both for stationary and mobile work. In addition, I began exploring user interfaces for elderly patient and their relatives. I would like to continue working on context-dependent visualization methods for integrated care by comparing solutions for different users.
7.2 Usability evaluations

In the field of HI, issues of usability have come to the fore. It is becoming increasingly clear that the ultimate acceptance or rejection of systems such as computerized patient records depend to a large extent on their usability (Kushniruk, Patel et al. 1997). Despite this, not many usability tests have been performed on health information systems; even less on handheld devices monitoring health documentation (Kushniruk, Triola et al. 2005). It is therefore imperative to continue the work of paper V (the usability lab study) for enhanced transfer of ICT tools between different care settings and/or areas.

Further usability studies will be conducted by observing staff in their daily work when using the new VHR. This will validate the requirements analysis previously conducted, and thereby allow for comparison of the work situations before and during usage of the new ICT system.

I will continue to cooperate with researchers from Caring Sciences. In interdisciplinary research settings we will investigate whether our system development methods and the developed products actually improve work in healthcare. The dynamics of healthcare staff using ICT tools in their daily work will be explored using methods from caring science in conjunction with usability evaluations. Research will focus on the acceptance, satisfaction, quality of work and perceived quality of care/life for staff and/or patients when ICT tools are used in daily work.

7.2.1 Transferability of developed systems

It is known that action research produces knowledge and insights that are grounded in the specific context being studied, and that initial solutions are limited to one test site and not generalizable (Kjeldskov and Graham 2003). However, the outcome may be transferred to similar contexts by means of a process of careful interpretation and translation (Miles and Huberman 1994). The transferability to other contexts depends on their similarity to the original context, in terms of key characteristics and aspects (Boivie 2005).

Even if we consider our method generally applicable, the usability lab analysis (paper V) revealed that the resulting system cannot be directly transferred to other settings, due to contextual differences. I therefore want to explore a process for communicating and applying the results to a new organization.

It is hoped this process will also address fast detection of the most serious problems and consecutive system redesign. Methods, based on usability lab studies, thematic seminars and observations, could support the transition. Moreover, I aim to optimize the MdTS method and will, in future projects, examine the time spent for each stakeholder and to what extent the number of seminars could be reduced.
Acknowledgements

*Science is built up with facts, as a house is with stones. But a collection of facts is no more science than a heap of stones is a house.*
  Jules Henri Poincaré (1854-1912)

I would like to add to the quotation that the house would be a lot more stable if mortar was used to cement those stone bricks. To me, mortar in the research is the research team, extended to the people involved in our action research.

Above all, I wish to thank my dear Dennis, for being there, for being who you are, for supporting me in my work on this thesis and in every other occasion. I take the opportunity to thank you for the great deal of effort you put into helping us to succeed with OLD@HOME and with everything else related to our R&D projects. You are XLNT!

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*Friends like you don’t grow on trees; I know that this is true,*
  *But if friends were flowers, there is no doubt*
  *How quickly I’d pick you!*
I want to express a particular gratitude to Professor Lind. Mats, thank you for giving me of your time *ceteris paribus*, for sharing your deep and broad knowledge of usability studies and how they best prove... Research is, if not easier (?), at least *more distinct*, with you and your pedagogical skills an e-mail away! 😊

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Isabella Scandurra
Uppsala, December 17. 2007
Att tänka fritt är stort, att tänka rätt är större.
(Uppsala universitets aula: Thomas Thorild, 1794)

- Att tänka själv är inte så illa det heller!
(broderad devis på Åsa Scandurras
realmössa, inför studentexamen 1965)

Att integrera användbarhet och hälsoinformatik -
Utveckling och utvärdering av IT-stöd i hemsjukvården

Den här avhandlingen består av ett antal artiklar som beskriver en ny multidisciplinär metod, som stöttar IT-utveckling i hemsjukvården, där många olika yrkesgrupper samverkar. Metoden har tillämpats i akttionsforskningsprojektet OLD@HOME och har resulterat i dels ny kunskap och dels ett implementerat IT-system, en Virtuell Patient Journal (VPJ). Denna VPJ har utvärderats i två olika användbarhets-
tester.

Trots en förväntad framtid med en växande äldre population, klart uttalade och allt större vårdbehov, ökade svårigheter att rekrytera vårdpersonal och en pressad ekonomi inom den svenska vården, så saknas tekniska stöd för hemsjukvården i Sverige (Essén 2003).


Denna avhandling behandlar möjligheterna att utnyttja teknik för att mer effektivt leverera och utföra vårdtjänster till äldre i hemmet. Framför allt
handlar detta arbete om hur IT-system ska utvecklas för att på bästa sätt leva upp till de krav som de ingående aktörerna ställer.

"Vad var känt redan innan den här avhandlingen?"

- Inom forskningsområdet Människa-dator Interaktion finns metoder som stöttar användarcentrering och samverkan vid utveckling av processorierade IT-system.
- Det råder brist på användbara IT-system i vården och det är känt att användarcentrerad design leder till mer användbara IT-stöd.
- Det är svårt att överföra den insikt och förståelse som framkommer under en verksamhetsanalys till de tekniska specifikationer som krävs för att kunna utveckla IT-system.
- Användarbarhetsutvärderingar tillämpas idag till viss del inom vården. Däremot är användbarhet sällan införlivad i de tidiga faserna vid utveckling av IT-system i vården.

Problem och lösningsförslag

Varför har inte fler försök som vården genomfört inom området sprids och övergått till rutinmässig verksamhet? Det finns organisatoriska, mentala, tekniska och ekonomiska orsaker till detta, inom såväl vården som hos leverantörer i industrin och i forskningen.

De lösningar som är aktuella kräver gemensamma investeringar, vilket är svårt med vårdens nuvarande splittrade ansvarsstruktur. Vidare är vårdens befintliga interna system i stort behov av att integreras och uppraderas, vilket sannolikt prioriteras framför införandet av nya lösningar. Framför allt är dock många inom vården omedvetna om vilka möjligheter dagens teknik medger. Det råder en stor osäkerhet vad gäller vilka konsekvenser nya tillämpningar för hemsjukvård kan medföra på budget, organisation och, inte minst, omsorgs- och medicinsk kvalitet (Essén 2003).

Sammantaget är användning och införande av nya IT-tillämpningar låg, inom vården i allmänhet, och inom hemsjukvården i synnerhet. Eftersom IT i vården traditionellt utvecklats för en yrkesgrupp, så tenderar dessa att inte stödja vårdprocessen. Detta blir särskilt tydligt i hemsjukvården då det samverkande arbetet som sker kring en patient utförs, inte bara av olika yrkesgrupper, utan även av olika organisationer som ska kunna kommunicera och utbyta information.

Jag har valt att studera dessa problem utifrån ett användbarhetsperspektiv. För att skapa den typ av IT-verktyg som saknas idag och som verkligen behövs, krävs att vården deltar mer aktivt i utvecklingen av nya tekniklösningar och blir en tydligare beställare. Från vården sida är detta komplicerat, eftersom det är svårt att formulera önskemål när det saknas lyckade exempel att utgå ifrån. Dessutom är det få som ser den långsiktiga nyttan av att involvera vårdpersonalen, de slutliga användarna, i IT-utvecklingsprojekt – de behövs ju bättre i vården där de gör direkt nytta!

90
Det krävs nya metoder för att kunna hantera komplexiteten i utveckling av IT-system för vård och omsorg, metoder som stöttar vårdpersonalens medverkan, som kan hantera olika intressenters behov och som direkt förbättrar för verksamheterna. Jag anser att en utvecklingsmetod inte bara ska resultera i ett nytt IT-verktyg, utan även inbegripa utformandet av förbättrade arbetssätt som kan sättas i relation till det nya IT-verktyget. Genom att integrera IT och verksamhet redan på utvecklingsstadiet ges möjligheten att skapa ett effektivt och hållbart arbete.

De artiklar som ingår i den här avhandlingen följer i stort utvecklingen av VPJ. Först beskrivs metoden i artikel I. Resultatet från tillämpningen av metoden presenteras i artikel II, som beskriver de specifika behov och krav som hemsjukvården har och som man bör ta hänsyn till vid utveckling av processorienterade IT-system för hemsjukvården. I artikel III presenteras de designförslag som togs fram för att möta hemsjukvårdens behov och krav. Dessa designförslag utvecklades genom att personalen i samarbete med utvecklare och forskare testade olika prototyper under utvecklingsfasen. Dessa förfinades stegvis tills de accepterades av vårdpersonalen. Artikel IV och V presenterar två olika användarbarhetsutvärderingar: en heuristisk inspektion genomfördes av experter och en utvärdering utfördes i ett användbarhetslabb där potentiella användare testade prototypen.

En multidisciplinär, tematisk seminariemetod (artikel I)

Den multidisciplinära tematiska seminariemetoden (MdTS) har utvecklats för att stöta utvecklingen av processorienterade IT-system. MdTS baseras på teorier från forskningsområden inom människa-dator interaktion (Human-Computer Interaction), i kombination med kunskap från hälsoinformatikområdet.

Metoden tar hänsyn till olika sociala, kulturella och organisatoriska faktorer som är relaterade till vårdprocessen. Den omfattar en kontextanalys som undersöker de olika användargruppennas behov, dels individuellt, dels i det interdisciplinära arbete de utför. Dessutom underlättar metoden överföringen av behovsanalysens resultat till de tekniska specifikationer som krävs för att utveckla ett IT-system som stöttar de olika arbetssituationerna inom hemsjukvården.

Hemsjukvårdens behov & mötande designförslag (artikel II, III)

Metoden tillämpades i OLD@HOME-projektet (Koch, Hägglund et al. 2005) med syfte att ge ett digitalt stöd till en obruten vårdkedja mellan distritkssköterskor, läkare och hemtjänst. De specifika behov och krav som arbetsgrupperna tillsammans kom fram till utgjorde underlaget för utvecklingen av den virtuella patientjournalen (VPJ). För att uppnå en obruten
vårdkedja ger VPJ personalen tillgång till information om vårdtagaren de besöker och möjlighet att dokumentera när de arbetar ute på fältet. Med hjälp av mobil teknik har de bland annat tillgång till gemensam vårdplan och gemensam läkemedelslista. Det finns möjlighet att rapportera utförda insatser och stöd för att kontakta annan personal när det behövs.

Data gällande vårdtagaren integreras från ett antal underliggande källsystem; primärvårdens läkar- och omvårdnadsjournaler samt hemtjänstens dokumentationssystem. Dessa sammanställs automatiskt.

Eftersom de olika yrkesrollerna har behov av olika vårdtagarrelaterad information består VPJ av ett antal olika vyer som ger personalen information som är relevant för just den arbetssituation de befinner sig i, till exempel de specifika krav som varje yrkesgrupp har då de jobbar i vårdtagarens hem.

Geografiskt testområde är Hudiksvall, som med dess fiberoptiska bredband mellan vårdcentral, äldreboenden och äldre i eget boende, har underlättat ett säkert införande av mobila IT-stöd för personalen inom vårdsektorn.

Iterativt framtagna prototyper har under en testperiod på fem månader använts i fält av personal som är inbjuden i vården av 18 testpatienter.

Utvärderingar av användbarheten (artikel IV, artikel V)

Två olika utvärderingar av systemets användbarhet har gjorts, till viss del för att närma sig en validering av den nya MdTS metoden, men även för att hitta potentiella användbarhetsproblem som måste åtgärdas innan systemet tas i dagligt bruk. Den första utvärderingen var en inspektionsutvärdering, dvs en heuristisk användbarhetsinspektion (Nielsen 1992) som undersökte hur användargränssnittet i webbapplikationen var designat gentemot tio vederstagna designregler för användbarhet. Den traditionella metoden kompletterades med en användaranalys för att i större utsträckning ta hänsyn till den kontext i vilken IT-verktyget ska användas, i detta fall hemsjukvård av äldre.

En kompletterande utvärdering genomfördes i ett användbarhetslabb (Dumas 1999). Syftet var att undersöka hur en ny grupp hemtjänstpersonal, som inte varit med i utvecklingen av systemet, skulle hantera VPJ. Denna utvärdering var viktig eftersom en nackdel med att tillämpa aktionsforskning är att de resultat som uppnås sällan är möjliga att överföra. Ett IT-verktyg kan till exempel vara begränsat till det testområde där det utvecklats och svårt att flytta till andra områden. Den PDA-lösning som utvecklades för hemtjänsten i Hudiksvall utvärderades således av åtta undersköterskor från hemtjänsten i Tierp. Vi utgick ifrån att de var vikarier i testområdet och endast hade fått en snabb introduktion till systemet.
Slutsatser

Resultat från användbarhetsutvärderingarna, tillsammans med de kvalitativa studier som gjorts med personalen som testat VPJ i drift, gav ett överlag positivt intryck. Få allvarliga fel hittades i den heuristiska utvärderingen och prototyperna ansågs väl anpassade till de olika användargruppen. Viktig information som behövdes ute i fält var tillgänglig på mobila enheter för respektive yrkesgrupp och presenterades på ett förståeligt sätt. I den här studien har MdTS metoden följaktligen visat sig fungera. Med hjälp av metoden lyckades vi finna och överföra de korrekta kraven från användarna, som resulterade i att VPJ ansågs användbar för de specifika användarna i de testade situationerna.

Arbetet bakom den här avhandlingen är intressant också för att den visar hur mobil IT kan stödja hemsjukvårdspersonalen som ett team. Däribligen ökar också samverkan mellan primärvårds- och kommunala vårdgivare och det i sin tur renderar i större kunskap om hur dessa samverkande processer fungerar och hur de skulle kunna fungera bättre.

Slutligen, i den här studien visade sig MdTS metoden användbar, den stöttade utvecklingen av användbara och processorienterade IT-system i hemsjukvården.
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