Formulating Design Requirements for a Clinical Handover System. A Usability Approach

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extend has been submitted for the award of any other degree of diploma of a university or other institution of higher learning.

David Kaufmann

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Abstract

Clinical handover is the process of transferring professional responsibility for patients between heath care professionals. Software systems are increasingly used to facilitate this process and the usability of these systems is critical to patient safety.

This research assessed the clinical handover at the Maternity ward in Auckland City Hospital with the main aim to formulate usability design requirements for a handover system. It also assessed the methods used for formulating the requirements.

The project was constrained by the need to work in an ongoing, real world environment with limited access to actual users. This was considered representative of many projects. A multi-method approach was undertaken using four different methods in response to the emergent needs of the project. The utilised methods were: user observation, survey, stakeholder interview and heuristic evaluation. All these methods were given a usability orientation.

The usability design requirements derived from the research showed that there is a need for a high degree of customisation of the system in order to facilitate differences in individuals' work styles and to align the interaction design for the system to the actual handover process. The display must be able to present the relevant information to a large audience. This can be realised by a presentation view that only displays information for one patient at a time. In order for the handover system to become the primary working surface, a user must be able to easily access all the required information and present it to his/her colleagues.

In regards to the methods used in this research, it can be concluded that each of the methods offered different insights into system usability. However, heuristic evaluation generated detailed and specific usability requirements while the other three methods mainly led to requirements that encompass usability among other aspects. Stakeholder interviews provided proof for the existence of usability events identified by the other methods.

Future directions for follow up research include the implementation of the generated usability requirements as well as the application of the chosen methods in domains other than health care.

Chapter 1. Introduction

1.1. Motivation

During my work experience in the IT industry, I have held various positions where I was involved in the testing of software and information systems. Despite great efforts and implementation of best practice test approaches, end users often complained about the resulting product. “The system does not do what I want it to do” was a statement often heard. It became obvious that testing against initially stated requirements was not enough. Rather, it seemed crucial to understand how users interact with the system in order to achieve their tasks. This awakened my interest in the study of usability and I enrolled into postgraduate studies at AUT where I focussed on this particular subject. During my coursework, I have conducted various usability related projects such as a usability evaluation of the “multisearch” function on the AUT Library webpage (Kaufmann, 2009) where I applied a combination of heuristic evaluation, usability testing and questionnaire. This project unveiled several ease-of-use and utility issues and suggested improvements such as the addition of buttons and more prominent feedback information.

In this study, I wanted to elaborate on usability evaluation and also apply it on a new type of users who might interact with a system in a different way. When Dr. Dave Parry suggested the project at Auckland City Hospital, it immediately captured my interest. I have never worked in the field of heath care before and anticipated that the different working style, paired with the “high risk” character of the medical field will provide for the difference in environment I was looking for.

1.2. Aim and approach

The main focus of this research was on the usability study of an IT system used during clinical handover by various medical practitioners at the maternity ward in Auckland City Hospital. The aim was to formulate how such an IT system can be improved in order to allow for more efficient and effective work. This distilled into the primary research question which states:

“What are the usability design requirements for a clinical handover system?”

It is anticipated that the results will not only assist the designers of the IT system used at Auckland Hospital, but also designers of similar systems elsewhere.

A secondary focus of this research was to assess the chosen methods in regards to their suitability for the study of usability. The aim was to inform usability practitioners who are tasked with similar projects and assist them in their choice and adaptation of methods.

The research used a multi-method usability evaluation which applied user observation, survey, stakeholder interview and heuristic evaluation. All methods have been given a usability orientation and were applied in response to the emergent need of the project. During the time of this research, the maternity ward in Auckland City Hospital changed the physical environment in which the handover took place, applied changes to the handover process and performed some minor configuration changes on the handover system. Subsequently, there were two iterations of usability evaluation, one pre-intervention and one post-intervention.

1.3. Structure of report

This report is composed of seven chapters: Introduction, Literature review, Methodology, Data analysis, Findings, Conclusion and Future work. The introduction describes the authors motivation and outlines the aims of the research project. Chapter 2 provides a review of literature that is relevant to the main concepts involved in this research. These are clinical handover, IT in health care, usability, methods used for the assessment of usability, the concept of method triangulation as well as requirements engineering. Chapter 3 provides information about the setting in which this research project took place, the applied framework and methods and also declares the authors background. Chapter 4 explains how the raw data resulting from this research has been analysed. Chapter 5 presents the findings of this research while Chapter 6 presents the conclusions of this research project and therefore provides the answer to the stated research question. Finally, Chapter 7 suggests directions for further research in the field of medical handover systems and user observation. The report also has several appendixes which provide detailed research results.

Preliminary findings of this research have been presented at the 2011 HINZ conference and exhibition (Kaufmann et al., 2011). The resulting presentation and paper are presented in Appendix E and Appendix F respectively.

Chapter 2. Literature Review

The literature review discusses relevant areas of previous work that are required for this research project in order to answer the research question.

Firstly, the literature review focuses on the area of health care; it discusses the process of clinical handover (section 2.1) and looks at the relationship between health care and information technology (section 2.2). This section emphasises the aspects of information technology that are unique to health care.

Next, the literature review shifts to usability, which is discussed with a focus on information technology. Section 2.3 gives an introduction to usability while the following section 2.4 outlines the ten main aspects of usability. This is followed by section 2.5 which gives reasons as to why the ten mentioned aspects are frequently not applied in a correct manner or not applied at all, leading to poor usability.

The usability part of the literature review is followed by a discussion of usability evaluation methods (section 2.6) and their application in conjunction, the so called ‘triangulation of methods’ (section 2.7). Similarly to the usability part of the literature review, the methods are discussed with a focus on information technology. Finally, the literature review completes with a review on requirements engineering (section 2.8).

2.1. Clinical handover

2.1.1. About clinical handover

The Australian Commission on Safety and Quality in Health Care (ACSQHC) (2010), whose recommendations are frequently applied in New Zealand, states that “Clinical handover is the transfer of professional responsibility and accountability for some or all aspects of care for a patient or group of patients, to another person or professional group on a temporary or permanent basis” (p. 4).

A professional group can consist of various clinical staff, such as midwives, nurses, doctors or allied health professionals. Its constitution is very much dependant on the particular context of the unit, ward or institution where the handover takes place. Clinical handovers frequently take place between incoming and outgoing shifts at hospitals. However, they do also take place in case of patient referrals or when an ambulance delivers a patient to the emergency department of a hospital. Overall, at least 7 million handovers occur annually in Australia (Jorm, White & Kaneen, 2009).

2.1.2. Problems observed around clinical handover

Clinical handover is a contributor to medical errors. Medical errors occur either when the correct action does not proceed as intended or the original intended action is not correct (Kohn, Corrigan & Donaldson, 1999). Both can be triggered by incorrect or insufficient information transferred at the clinical handover. Resulting medical errors – include discontinuity of care or administration of wrong medication. A survey conducted by McCann, McHardy and Child (2007) at Auckland City Hospital found that 72 out of 73 medical practitioners had experienced at least one clinical problem due to poor clinical handover in the three months preceding the survey. Further, the Australian Commission on Safety and Quality in Health Care (2010), refers to studies which unveiled that 95% of Australian doctors believed that there were no formal procedures for handovers and that, for emergency department handovers, not all required information has been passed over in 15.4% of the cases. As a result, Lingard et al. (2011) conclude that "Communication breakdown is the most frequent cause of adverse events across all healthcare settings".

Besides those statistics, tragic individual cases alert to the fact of poor clinical handover. For example, Jorm, White and Kaneen (2009) mention a case from Australia where an elderly man died of dehydration and pneumonia. The man had been admitted to a local hospital and, upon his release on a late Friday afternoon, was flown back to his rural community. The community health facility had been informed by a fax of the patient’s arrival. However, this fax was not attended to until Monday morning, which meant that the patient was left alone at the remote airstrip, causing his death.

2.1.3. Applied techniques for clinical handover

The handover process frequently employs visual aids in order to show detailed information about patient’s medical conditions and immediate needs. In one example, the Middlemore hospital in New Zealand uses a large handwritten whiteboard for that particular purpose. It is argued that this system works very well due to the fact that the whiteboards large size allows all participants at the handover to see the information clearly (Li, 2011). In contrast, the Women’s Health Department at Auckland City Hospital (ACH) deploys a software application that presents the information on a standard PC screen. When comparing these two visualisation approaches (e.g. whiteboard visualisation vs. computerised visualisation), several advantages for each approach have been discussed. On top of the already mentioned good visibility provided by the whiteboard approach, it also offers only a limited space that can be filled with information about each patient. This limitation is regarded as a positive encouragement to keep the whiteboard free from any “unnecessary clutter” (Li, 2011, p. 60). Moreover, the whiteboard visualisation technique is also not affected by computer system outages. On the other hand, the computerised visualisation employed at Auckland City hospital allows for better privacy as the screen is smaller in size and can be switched off if needed. Further, it allows for data storage, which can often be required by a hospitals policy in regards to record keeping of patient information. Finally, the computerised approach also allows for integration with other systems in order to retrieve data.

In addition, both hospitals use an electronic template that can be printed out and used by the participants during the handover in order to assist them in taking handwritten notes. It is argued that “this aids information retention and comprehension of the clinician situation” (Li, 2011, p. 60).

2.1.4. Suggested improvements to clinical handover

As a result, much work has gone into the improvement of the clinical handover. Among others, process improvements and increased application of Information Technology as an aid have been suggested. Information Technology can be further split into software (i.e. patient database) and hardware (i.e. screens for information display). However, because of the complexity and potential for serious error associated with handover, any application of IT must have excellent usability.

Process Improvement

ACSQHC (2010) proposes a variety of processes which aim to improve various aspects of clinical handover.

Firstly, the OSSIE process is aimed at medical practitioners tasked to improve the medical handover process at their institution. It gives guidance by suggesting which tasks need to be conducted at what stage.

Secondly, the HAND ME AN ISOBAR process suggests the minimum set of activities to be executed prior and during a clinical handover. The ISOBAR mnemonic of this process stands for the information to be handed over for each individual patient. The acronyms for the processes are explained in more detail in Table 2.1.

Table 2.1

ACSQHC handover process

Process for handover process improvement - OSSIE	
O	Organisational leadership
S	Simple solution development
S	Stakeholder engagement
I	Implementation
E	Evaluation and maintenance
Process for overall handover - HAND ME AN ISOBAR	
HAND	Mnemonic for preparation tasks to be done prior to commencement of handover.
ME	Mnemonic for organisational tasks to be done at the start of the handover (e.g. ensure that all required participants are present).
AN	Mnemonic for 'environmental awareness' (e.g. patients of concern or patients and staff movement).
ISOBAR	Mnemonic for the handover of an individual patient. See below.
Process for individual patient handover - ISOBAR	
I	Identification
S	Situation
O	Observations
B	Background (e.g. medical history or social problems)
A	Assessment and actions (e.g. next step in treatment process)
R	Responsibility (e.g. who is responsible for the patient after the handover)

Apart from the use of proformas, there are more radical suggestions in regards to process improvement. One frequently cited suggestion is to conduct the handover in front of the patient. However, this has several implications, for instance if the patient has a terminal illness or social issues such as aggressive and/or abusive behaviour towards medical staff. Other suggestions, which address medical errors as a whole, include the implementation of strong mandatory reporting efforts, increased regulation and more funding for research in the area of medical errors and their prevention (Kohn, Corrigan & Donaldson, 1999).

2.2. Information technology in health care

Literature often suggests an uneasy relationship between information technology and health care. Karsh, Weinger, Abbott and Wears (2010) suggest that “Health Information Software has commonly been identified as being among the least reliable” (p. 618) while Collen (1995) goes as far as stating that “Developing a comprehensive medical information system appears to be a more complex task than putting a man on the moon has been” (p. 464). Researchers suggest a variety of causes that lead to the stated problem.

Firstly, healthcare is a complex sociotechnical system where many parts of the delivery are messy and non-linear (Karsh et al., 2010). To make things even more complicated, the decision making processes in health care are often entirely unknown to outsiders. For instance, a junior doctor might frequently informally negotiate with nurses in a process to determine on how to treat a patient. However, since doctors are formally responsible for the care of the patients (as opposed to nurses) such communication cannot be documented openly. This is in stark contrast to the well-structured and linear mindset required for writing software. As a result, designers often assume a rationalised model of healthcare delivery (Karsh et al., 2010) and try to incorporate their understanding of the decision making processes into a system, using “best practices” such as pre-fixed sequences of steps and restricted data entry (Berg, 1999). This leads to systems that will be used incorrectly or not be used at all.

Secondly, the work pattern of many health care professionals is characterised by a high degree of mobility which is paired with limited access to IT systems. Thus, the use of paper is widely spread. Further, it has been found that paper supports users’ cognitive need in a way that IT systems cannot (Karsh et al., 2010). This creates an environment where the IT system does not provide the primary working surface and, as a result, does not hold the information required by the practitioners.

Thirdly, health care IT is often viewed differently from medical devices (e.g. a cardiac pacemaker). While devices need to be approved by government agencies (e.g. FDA in the United States), there is no such process for health care IT. This might be due to the belief that humans will make the ultimate decision and IT systems only assist in this process. However, this belief might be incorrect as research has shown that people will accept wrong solutions when suggested by an IT system (Karsh et al., 2010).

Apart from the above causes, it has also been found that IT systems are often developed primarily for non-users. This could be the case where a system is introduced in order to fulfil an auditability requirement. Also, health care IT is frequently developed in a 'one size fits all' manner (Karsh et al., 2010), omitting the fact that various user groups (e.g. nurses and doctors) might have different requirements.

In order to overcome the issues associated with above causes, Berg (1999) suggests a number of approaches that can be applied for IT projects within the health care sector. This includes a step by step development with frequent releases, which allows technology and work practice to evolve together. These frequent releases would mean that the different activities forming the software development lifecycle (e.g. analysis, design, implementation and evaluation) become less distinctive. Further, Karsh et al. (2010) also recommend the application of user observation during the evaluation phase as the mentioned informal decision making process cannot be understood by evaluating written process documentation or organisational charts. Last but not least, the application of 'best practice' in IT design should always be viewed in the context of the systems use.

2.3. Introduction to usability

2.3.1. Definition of usability

Ever since the creation of the first human computer interfaces, there has been a large amount of research in regards to usability. With the invention of the Web, this process has been further accelerated, admitting the importance that usability plays for webpages. A frequently cited (e.g. Alshamari & Mahyew, 2009) high level definition of usability has been provided by the International Standardisation Organisation (ISO) (1998) which defines usability as "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (p. 2).

The three terms of ‘effectiveness’, ‘efficiency’ and ‘satisfaction’ can easily be translated into a modern day software, for instance a software application that is used during clinical handover. The software is effective if the specified user (e.g. nurse) can update a patient’s health condition without specialised domain knowledge that exceeds her/his own one or without specialised IT knowledge. It is further efficient if he or she can do this within an acceptable time and without the need to utilise another working surface to accomplish the task (e.g. a paper note given to another user). Further, the software is considered ‘satisfactory’ if the user has been left with a positive impression and is likely to reuse it. Also, it is important to consider the statement ‘in a specified context of use’ in the definition given above. It highlights the fact that, although a software could have an excellent usability, it can still be completely useless if there is no specified context of use. This has also been mentioned by Buxton and Greenberg (2008) who state that “the technological landscape is littered with unsold products that are highly usable, but totally useless”.

While most researchers agree on what usability encompasses, there are several definitions that differ from the one given above. This wealth of specification attempts can be attributed to the fact that usability is still an emerging and expanding discipline and therefore, there is not yet a defined and agreed set of definitions and ontology.

For the purpose of this study, the term usability is defined accordingly to the above ISO specification.

2.3.2. Definition of usability event

Usability of an artefact can be impacted by a myriad of factors, both in a positive or negative sense. Some of the potential impacts on usability are outlined in section 2.4 (usability aspects) and section 2.5 (usability challenges) of this literature review. For the purpose of this project, such usability impacting factors are called ***usability events*** and are defined as an occurrence or feature that impacts the usability of an artefact in a positive or negative sense.

In essence, every event that affects the actual or perceived effectives, efficiency and/or user satisfaction of an artefact is a usability event. This also includes events that lead people NOT to use the artefact in first instance.

2.3.3. Reference disciplines for usability

The field of usability is influence by a number of other scientific disciplines. Preece et al. (1994, p.38), who focus on Human Computer Interactions, define the list of reference disciplines as shown in **Error! Reference source not found.**.

Table 2.2

Reference disciplines for usability (adapted from Preece et al, 1994)

Reference disciplines for usability	
Major contributors	Minor contributors
1) Computer Science	5) Engineering
2) Cognitive Psychology	6) Design
3) Social and organisational Psychology	7) Anthropology
4) Ergonomics and human factors	8) Sociology
	9) Philosophy
	10) Linguistics
	11) Artificial Intelligence

2.3.4. Conceptual model of user-artefact interaction

In his book entitled *The Design of Everyday Things*, Norman (2002, p.47), provides a basic process for user-artefact interaction and splits this into seven distinctive ***states of action***. These are:

- State 1 - Goals: Each user-artefact interaction is triggered by a goal, which is the thing the user wants to achieve with the help of the artefact. As for a user in a clinical environment, the goal could be to obtain the Body Mass Index (BMI) of a particular patient.
- State 2 - Intention to act: This state acts as a translation between the goal and the resulting actions by determining the type of support to be used in order to achieve the goal. In our particular example, the BMI could be obtained by either

asking a colleague, measuring the patients height and weight or by searching for the information in the patient information system. For the purpose of this example, we assume that the user intends to look up the information in the patient information system.

- State 3 - Sequence of actions: This state is concerned with the user mentally outlining the steps that he or she needs to undertake in order to achieve his or her goal with the help of the artefact. As for the patient information system, this could be: 1) logging into the system, 2) entering the patients NHI number into the search box, 3) clicking on the “search” button, 4) waiting for the result to be displayed on the screen, 5) searching for the filed that show’s the patients BMI.
- State 4 - Execution of the action sequence: This state is the actual execution of the steps outlined in state 3 with the help of the artefact.
- State 5 - Perceiving the state of the world: This state is concerned with the user perceiving the changed state of the environment (e.g. the “world”) after the actions have been executed during state 4. In our case, the user might check the screen of the patient information system in order to see whether the system returned the correct patient and presents the patients BMI value.
- State 6 - Interpreting the perception: The user interprets the perceived changes. As for the patient information system, the user reads the value that the system presented for the patient’s BMI.
- State 7 - Evaluation of interpretation: In this state, the user evaluates the interpretation in order to ensure that his or her goals have been met. In our example, the result of the evaluation could be that the given BMI value is not deemed correct by the user (e.g. the patient, which is known to the user, is not obese, while the BMI displayed by the system clearly indicates an obese person). If this is the case, the goal has not been met and the user falls back to state 2. This time however, he or she will likely choose another means of support in order to achieve his or her goal (e.g. asking a colleague).

2.4. Usability aspects

This section of the literature review outlines ten aspects that define usability. The grouping of these aspects loosely aligns with the ten heuristics defined by Nielsen and Mack (1994). This grouping has been chosen as Nielson and Mack's heuristics are widely cited, frequently used and well regarded by usability experts. Further, they do provide a good domain fit as they have been created for the purpose of assessing usability in the field of information technology while other suggestions (e.g. Norman, 2002) have a wider context.

Each of the ten aspects can be achieved by the application of concepts that have been suggested by various authors. While the focus and writing of this section is concerned with usability in the field of information technology, it also introduces concepts from authors who discuss usability in a wider context.

2.4.1. Visibility and system status

This aspect of usability addresses how the artefact interacts with the user through the presentation of visual cues. This can be achieved through physical features of the artefact itself or, more importantly in the field of information technology, through the information presented on a graphical user interface (GUI).

The commonly discussed concept of visibility (e.g. Nielsen & Mack, 1994) means that the system should inform the user about its current status as well as the occurrence and/or progression of status changes. This is due to the fact that if there is no apparent result, the action is regarded as inefficient by the user, leading him or her to repeat it (Norman, 2002). Visibility can be achieved by making status changes clearly visible and through the display of system messages where the status change is not obvious or in case the progression of status change takes more than a few seconds.

Various authors expand further on visibility and provide additional concepts that are associated with this particular aspect of usability.

Norman (2002, p.52ff), who points to visibility as one of four key usability principles, suggests that an artefact, such as an IT system, should provide visible constraints. A constraint is a design feature that naturally prevents a user from using it incorrectly. There are four types of constraints as follow:

- Physical constraint: A physical feature of an artefact that forces a correct use. An example is a three hole power socket which only allows the plug to be inserted in one possible (i.e. the correct) way.
- Semantic constraint: This constraint relies upon the user's knowledge of the situation and/or world. For instance, it is instantly known which seat of a car is a driver's seat.
- Logical constraint: A logical feature that drives correct use. For instance, when assembling a peace of furniture, it appears logical to the user that all given pieces must be assembled in order to complete the task. Hence, the user would not stop assembling until a place for the last piece has been found.
- Cultural constraint: An artefact can exhibit constraint that are neither physical, semantic nor logical, yet are still understood by most users. For instance, in most cultures, the colour red is associated with the meaning "stop". This understanding can be incorporated into a display accordingly in order to improve its visibility.

Further, Perrow (2007, p.39) states that visibility cannot only rely on colour and must present system status in other means (e.g. written text) in order to make the system usable for impaired users, such as colour blind people.

2.4.2. Match between system and real world

This second aspect of usability addresses how well the system reflects the user's understanding of the world.

Same as for visibility, there are various concepts presented by a number of authors which address this particular aspect of usability.

The first is the one of providing a ***conceptual model***, which can be achieved by providing clues in the design of an artefact (Norman, 2002, p.52ff). A clue is a design feature that naturally matches a user's perception of use. An example is a door where the handle is long and horizontal on the 'push' side and short and vertical on the "pull" side. This door leads to a lower rate of usability issues as most people naturally relate to the long handle to push and to the short one to pull.

The second concept is the one of mappings. This is the possibility to determine the relationship between action and result (Norman, 2002, p.52ff). Mappings can be achieved by a sensible design of a control panel. For instance, if a control allows the user to increase the heat in a room (regardless whether the slider is a real or virtual one), then it should be placed vertically. Shifting the slider up should increase the heat while shifting it down will decrease the heat. This is due to the fact that most people associate certain directions with increase respectively decrease.

A further concept is that the system should speak the user's language and processes information in a way similar to the user.

2.4.3. User control and freedom

This aspect is concerned with providing a way out if users went to the wrong place. This can be best achieved by providing a menu on each page of a webpage or system and by putting a clearly visible **Home** button into the menu.

2.4.4. Consistency and standards

In order to enhance usability, it is not only important to use a terminology and concept that are familiar to users (see 2.4.2), but also use them consistently throughout the entire system.

Further, it is important to understand the value of standards. This includes formal standards, as well as de facto standards. This concept is highlighted by Pearrow (2007, p.50), who stresses the importance of understanding previous user experience with similar systems in order to provide a good match between them and the system. He gives an example where a usability test for a banking application showed that participants missed finding an important navigational feature. Upon investigation, it became clear that the participants had unconsciously ignored the animated image that served as a hyperlink because it had the look and placement of an animated advertisement. On the positive side, a system's search function could leverage users familiarity with the search engine Google® by providing a button called 'I'm feeling lucky'. Due to familiarity, most users would correctly assume that, upon clicking this button, the system would directly open the page that comes at the top of the search results list.

2.4.5. Error prevention

Norman (2002, p.105ff) divides errors into mistakes and slips. A mistake occurs if a user consciously performs the wrong task on an object. A mistake could hence be related to insufficient user training. In contrary, slips represent situations where a user unconsciously performs the wrong task, leading to an error. Slips fall into the following six sub-groups:

- Capture error: the execution of the wrong task, triggered by the fact that the right task starts with the same steps as the wrong one;
- Description error: the execution of the right actions on the wrong object;
- Data driven error: the mix-up of numbers;
- Associate activation error: saying the wrong thing;
- Loss-of-activity error: forgetting the goal of a task while executing it;
- Mode error: the mix-up of similar or same looking objects (e.g. buttons).

Normans division into mistake and slip aligns with Kohn, Corrigan & Donaldson's (1999) classification for medical errors (see sub-section 2.1.2): A mistake represents an event were the intended action is not correct and a slip aligns with the case were the correct action does not proceed as intended.

The above errors can be avoided through the application of clever design.

For example, data driven errors can be prevented to a certain extent by implementing input checks. Also, if an input value has a specified length and format (e.g. an NHI number), the system can provide a textbox that only allows the user to enter the expected number of digits. Such a design element that discourages use in an improper way is called a ***constraint*** (Pearrow, 2007, p.46). Likewise, when there is a number of entry possibilities (e.g. a date), a selection list (e.g. in form of a calendar) should be considered.

2.4.6. Recognition rather than recall

In regards to usability, it is important to consider where to place the knowledge of how to use an artefact. Norman (2002) sees two possibilities for this:

- Knowledge in the world (external information). This refers to knowledge that can be obtained by looking, listening or touching an artefact (e.g. considering its constraints).
- Knowledge in the head (internal information). This refers to knowledge that a user has had to obtain, either through training or experience. This type of knowledge is further split into declarative knowledge, which can be explained and learned relatively easily (e.g. road rules such as to stop at a red light) and procedural knowledge, which is difficult to explain and learn (e.g. how to ride a bike).

While heuristics described by Nielson and Mack (1994) call for placing knowledge in the world (i.e. recognition), Norman (2002) is more sceptical about this and argues that the placement of knowledge depends on the situation. When considering the place of knowledge, it must be understood that both, knowledge in the world and knowledge in the head have advantages and disadvantages. For example, knowledge in the head is not readily retrievable for an untrained user (unless it is part of the 7 +/- 2 items that are typically stored in the short term memory), difficult to learn and frustrating at the first encounter with an artefact. On the other hand, knowledge in the head is typically more efficient and can improve an artefact's design as it does not need to provide constraints or excessive labelling.

2.4.7. Flexibility and efficiency of use

The trend in information technology is for products to become more complex and contain a larger amount of features (Pearrow, 2007). According to Cooper, Reimann and Cronin (2007) this will inevitably "increase the cognitive load and navigational overhead for all users" (p. 77). One way to address this issue is to build flexibility into the system and allow users to adjust it to their own needs, for example through the introduction of customised user layouts which hide unused functionalities. However, too much flexibility is in partial conflict with the usability aspect of consistency and standards. Hence, different levels of flexibility should be given to different user types. For example, an administrator could have a higher level of flexibility in order to adjust the system to the organisation's overall needs while a user should be given a lower level of freedom which ensures a user experience that is similar to that of his or her peers.

2.4.8. Aesthetic and minimalist design

This usability aspect calls for an attractive artefact design. Although design might initially not be linked to usability, Cooper, Reimann and Cronin (2007, p.90), refer to studies which demonstrated that users initially judge attractive interfaces to be more usable. Further, this belief seemed to persist after the artefact had been used and even in case of the occurrence of real usability issues. Further, an attractive design is often the incentive for a user to buy a particular product and hence important from a commercial point of view (Pearrow, 2007, p.8). In order to achieve an attractive design, the artefact's designers should refrain from excessive use of frills such as a wide variety of colours or decorative motives.

This usability aspect is in conflict with the usability aspect of visibility. This is due to the fact that what might look as highly visible to a usability expert could be regarded as unnecessary clutter by a designer. Yet, both aspects contribute to the overall usability of a system as they both ensure adherence to the core usability criteria of user satisfaction. Hence, Pearrow (2007) argues that "the usable medium is a compromise that lies somewhere between optimal usability and optimal design" (p. 8).

2.4.9. Help user recognise, diagnose and recover from errors

Norman (2002) argues that typically a user not only blames himself or herself for the occurrence of an error, but also acquires a state of ***learned helplessness*** in case an error occurs multiple times and he or she is not able to recover from it. Consequently, this has a significant impact on usability as the user's satisfaction is severely hampered by the emotional impact the errors and unsuccessful recovery have caused. Hence, error recognition forms an important usability aspect.

When recovering from errors, users typically start the investigation at the lowest level. For instance, if a user intends to recover from a non-functional internet connection, he or she might first check the detailed browser settings (low level) before verifying whether the modem is switched on (high level). Error recovery needs to take this behaviour into account and provide the user with help suggestions that initially target at potential high level causes for a problem.

2.4.10. Help and documentation

This tenth and last usability aspect is closely related to the fifth (error prevention) and ninth ones (error recovery). It is always better to prevent errors from occurring or, if they do happen, let the user recover from them without the help of a manual. However, it would be unrealistic to believe that there will be no situation where a complex error occurs that has not been catered for. In such cases, a help function or a manual (electronic or hardcopy) is required. Electronic manuals can be greatly enhanced by providing keyword search functionality. Also, a FAQ section could be provided and frequently updated based on real world questions asked by users. Such an up to date FAQ facility has the advantage that it clearly highlights real usability issues and serves as an excellent input for a subsequent release of a system.

2.5. Usability challenges

This section of the literature review outlines a number of factors that are frequently cited causes for poor usability. Most often, these factors are the reasons for not applying the usability aspects outlined in the previous section.

2.5.1. Rapid product evolution

In literature, many discussed usability issues have been accompanied by a rapid evolution of a given product, meaning that the usability aspects outlined in section 2.4 could only be met if the design of the product was changed fundamentally. A good example for this is the telephone. Over a long period of time, the telephone’s functionality has been very static as it was only used to make and receive phone calls. However, the last 20-30 years have seen a rapid evolution of the telephone, which can partially be linked to the raise of Information Technology. This has resulted in a vast number of features that have been added to the conventional telephone, such as call wait, call hold, voicemail, automatic callback, to name only a few. The dilemma the telephone designers faced was to marry a wealth of useful “new world” features with the established and equally useful “old world” design of the telephone. We now know that this is not possible and that multi-party call conferences, customised announcements and multiple voicemail boxes have to be managed by the use of a computer as opposed to a device that has 12 buttons and no graphical user interface. However, this fundamental change of the telephone took almost three decades to occur.

During that time, users had to cope with a large number of devices that have been very painful for them (Norman, 2002).

2.5.2. Conflicting product requirements

Another factor that often leads to poor usability is conflicting product requirements. Two types of requirements that often interfere with usability are requirements in regards to the prospective products price and the product design. For a large number of customers, the price is a key point for selecting one product over another. This means that the producer needs to cut the cost for development and production. This could be achieved by reducing testing costs during the development phase and by the non selection of a graphical user interface for user feedback. Aesthetic design is often a key requirement for fashionable products and a number of consumer electronics falls into this category. Here, looks are often traded for usability. This could be well justified as research has shown that users judge attractively designed artefacts as more usable and that this belief often persists for a long time (Cooper, Reimann & Cronin, 2007, p. 90). A solution to requirement conflicts could be to weigh the importance of each requirement. The weight will then decide if one requirements needs to be met over another.

2.5.3. Forcing functions in design

The user's perception of usability can be negatively impacted by forcing functions that have been put into the design. A forcing function is a functionality that prevents improper use of the system that could lead to unwanted or dangerous outcomes. Norman (2002, p.140) categorises forcing functions into ***interlock***, which forces a correct sequence, ***lockin***, which does not allow a user to exit until certain actions have been performed, and ***lockout***, which prevents a user from entering a system (e.g. after entering three times the wrong password). Although some forcing functions might be necessary, they are often regarded as frustrating by the users.

2.5.4. Denial of usability issues

Finally, usability is frequently compromised by the wrongful denial of usability issues. Such an example was mentioned by Norman (2002, p.35). The author criticised a system due to the fact that users might mix up the "backspace" with the "enter" key, leading to an undesired outcome. The designer of the system referred to the manual, which clearly highlights the functions of each key. However, as users naturally mix up these two keys, this does compromise usability and needs correction, regardless whether or not is has been mentioned in the manual.

2.6. Usability evaluation methods

The improvement of an existing artefact or the design of a new one inevitably requires the usability expert to apply one or multiple usability evaluation methods in order to elicit the usability requirements and/or verify the usability of the artefact. There is a wide range of proposed methods and Wikipedia (2011) presents as many as 24 different evaluation methods, giving a clear testimonial of the complexity, obvious differences as well as the fact that usability is still an emerging field of science. This section of the literature review discusses some commonly used usability evaluation methods. It needs to be mentioned that certain methods, such as ***think aloud*** (aka ***moderated usability test***), are "pure" usability methods that are mostly used for that particular purpose only (i.e. evaluation of usability). Other methods are not solely restricted to usability studies and can therefore be deployed in various fields of science. For instance, an observation method can be used for both usability and animal studies. While certain methods have various fields of application, the literature review focuses on their deployment for usability studies.

2.6.1. User observation

User observation is a popular way in order to assess an artefact's usability. Hence, this subsection discusses options for user observation in detail. However, whatever choices will be made, user observation must prevent the occurrence of the so called ***Hawthorne Effect***, which is "the hyper-normal functioning of an individual under observation" (Pearrow, 2007, p. 68). This would likely falsify the research outcome and lead to wrong interpretations and/or design recommendations. Therefore, Preece, Rogers and Sharp (2002, p. 363) conclude that the "goal [of user observation] is to cause as little disruption as possible". However, this view is contested and different variations of the observer role might not lead to user disruption. Hence it is argued that 'reflection on the task' does not necessarily have an unsatisfactory, disruptive impact on users experience (Carter, 2007).

Role of the observer

Prior to the observation of any human interaction, regardless whether it is related to the use of an artefact or simply to the interaction between people, the evaluator must ask himself or herself what role he or she is going to take during the observation. Different authors suggest between two and five different variations of this role. Each variation generally distinguishes itself by the degree to which the observer is involved in the interaction and by the amount of specialised knowledge he or she possesses. For the purpose of this thesis, these two factors are called ***evaluator involvement*** and ***evaluator knowledge***. Preece, Rogers and Sharp (2002, p. 361), define three different evaluator roles which they call ***onlooker***, ***participant observers*** and ***ethnographers***.

Firstly, an onlooker evaluator does not get directly involved in the interaction, nor is he or she likely to possess any in-depth knowledge of the artefact and/or interaction being observed (apart from an understanding that can be regarded as general knowledge). This evaluator role is most useful when there is a need to collect data that can be extracted from pure behavioural observation, for instance the percentage of time a student uses the mobile phone while in the library. The onlooker role should also be considered when the evaluator's involvement might overly distract the interaction or use of the artefact. Further, this role might need to be chosen if external circumstances prevent a more in-depth involvement. This could be the case when observing Air Traffic Controllers in their live environment.

Secondly, a participant observer does get involved into the interaction, for example by asking targeted questions while a user works with a particular software (so called ***moderated usability tests***). Therefore, this role requires the evaluator to have more detailed understanding of the interaction or artefact observed. However, according to Pearrow (2007, p. 4), he or she does "not have to be an expert or have intimate knowledge of the item being evaluated". The participant observer role is most useful if there are limited possibilities to record an interaction and/or if there is no possibility to interview a user after the interaction. This requires the moderator to immediately inquire about the user's actions in order to understand his or her thinking. However, unlikely to an ethnographer, the participant observer does not completely immerse himself or herself into the user's role nor is he or she regarded by the users as one of them.

Thirdly, an ethnographer evaluator gradually becomes an active participant of the observed culture or community, which allows him or her to unrestrainedly involve in the interaction and record extensive filed notes. In order to become an active participant of the community, the ethnographer is required to do a large amount of study as he or she is not only required to learn about the artefact or interaction, but also about the social conventions of a group. This results in the evaluator acquiring a vast amount of knowledge. The ethnographer observer role can be a useful tool when studying interactions in subcultures which might be difficult to reach for an outside researcher. However, it might not always be feasible for an observer to become an ethnographer. For instance, a middle-aged evaluator is likely to struggle in an attempt to become an ethnographer observer within a teenager subculture. Also, it needs to be considered that an ethnographer might become biased by the involvement in the studied culture.

It should be noted that literature does not always draw a clear line between a participant observer and an ethnographer and that some literature does not regard an ethnographer as observer at all.

Technical support for observation

Video has frequently been cited (e.g. Dowrick, 1991) as a tool that provides enormous value in the field of behavioural sciences. Given the fact that 82% of the information is absorbed via the eyes and 11% via the ears (Pease, 2006, p. 71), it is not hard to understand why a video recording (combined with sound) is such a powerful tool. Carter (1997, p.46) outlines the following advantages of video recordings in the field of user observation:

- **Sensory-rich memory cues**
  By using video, critical information, such as tone of voice, facial expression and body language can be captured. The accurate recording of these cues can be crucial for correctly interpreting an interaction.

- **Control over viewing**
  Today's video editing software allows for careful and thorough analysis of information. For instance, an observer can pause the recording or zoom into a particular sequence (provided a high resolution camera has been chosen) if needed.

- **Enhanced awareness**
  Humans quickly forget negative events and experiences of their past and "tend to explain their own roles more generously than others do" (Dowrick, 1991, p. 97). This behaviour makes sense evolutionary-wise as there is no survival value in continuously remembering negative past experiences that cannot be changed. However, this evolutionary effect is counterproductive in the area of user observation as a user is likely to retrospectively describe an interaction as more successful than it actually might have been. Hence, video recordings can assist in highlighting possible problems and lead to an enhanced awareness.
- **Convenience**
  The capabilities of today's video recoding devices and video editing software are extremely advanced. Combined with the possibilities given by the internet (e.g. sharing of video clips), makes video recording a very convenient recording technology for user observation.
- **Non-evasive**
  During video recording, observed participant are typically not interrupted in their interaction with the artefact or other people, leading to a natural dialog. This is in contrast to other recording approaches where the observer, due to lack of recording possibilities, might be forced to apply more interrupting observation techniques (e.g. the think-aloud technique where the user is required to express their thoughts verbally). Also, if video recording is conducted in a professional manner, users often forget that they are being observed (Preece, Rogers & Sharp, 2002, p. 363), adding to the non-evasive nature of video recording.
- **Useful in analysis**
  Video can be a useful tool in identifying trends that can be used in order to categorise data. For instance, an observer can compare two video sequences in order to look for analogies.

Apart from the above advantages, video can also play an important part in informing key stakeholders about strengths and weaknesses of a product. This has been highlighted by Pearrow (2007, p. 66) who argues that "data on paper might not have the same compelling force to decision makers and designers as a video of a real user."

Despite the above advantages, there are a few points that need to be considered respectively addressed when utilising video during observations.

Firstly, in order to prevent the already mentioned ***Hawthorne Effect***, it is important to make the observed user feel comfortable and at ease.

Secondly, due to the position and angle of the video camera, it might not be possible to capture all the events of interest to the observer. This could be the case when a large number of people are being observed in a room.

2.6.2. Survey

According to Saris and Gallhofer (2007), a survey is a "data collection operation that gathers information from human respondents by means of standardised questionnaire" (p. 1). Surveys are one of the most popular qualitative research methods. Research on surveys has shown that they are the method of choice in 28.9% (political science) to 48.7% (psychology) of the cases (Saris & Gallhofer, 2007, p.3). This popularity is due to the fact that surveys are a cost- and time-effective tool for collecting primary data from a sample size of the overall population (Rea & Parker, 2005, p.7). Surveys can be conducted anonymously, easily replicated and the standardised set of questions and answer options make the activities of coding, data analysis and interpretation relatively easy. On the negative side, surveys do not allow for qualitative research, such as detailed elaboration on given answers. Also, if the questions and answer are ill defined, surveys might tempt the respondent to give biased answers or not answer the research question at all.

Surveys can be designed in many different ways. One popular option is to provide the user with a visual analogue scale between two opposing statements; called poles (e.g. 'agree' and 'disagree'). The user then can answer the question by placing a cross on the scale. If conducted appropriately (e.g. poles are opposing statements), this type of survey can provide precise answers (Saris & Gallhofer, 2007, p.109).

2.6.3. Stakeholder interviews

Selection of stakeholders

When considering stakeholder interviews, the first question should be *whom* to interview. According to Cooper, Reimann and Cronin (2007, p. 56), "users of the product should be the main focus of the design effort". Hence, one could argue that the improvement or development of an artefact solely requires user input. However, while the users play a crucial role, it needs to be considered that other stakeholders can be present as well. For instance, when working on an enterprise product or consumer products targeted for children, it should be considered that the people who purchase the products (i.e. customers) are unlikely to be their main user or be a user at all. Nevertheless, it would be wise to include these stakeholders as they might be crucial for the commercial success of a product. For instance, while a parent is unlikely to use a computer game purchased for the children, his or her perception of the graphics (e.g. violent) can decide whether or not the product will be recommended to other parents. Likewise, a general manager might see a particular accounting software only for a few minutes at a sales presentation, however this short time span can possibly decide about a product's failure or success. Another stakeholder group to be considered in the area of software are administrators. While not being the main users, they will be required to support either the software product or the platforms which host it. Last but not least, Subject Matter Experts (SMEs) are a valuable source for enquiries. SMEs are typically "experts on the domain within which the product will operate" (Cooper, Reimann & Cronin, 2007, p. 54) and can provide the usability expert with important knowledge. This can be valuable in areas where extensive domain knowledge is required, for instance when developing software for medical purpose.

In regards to the number of stakeholder to be interviewed, Virzi (1992, Cited in Garmer, 2003), cites that there is a saturation point that will be reached "after between 12 and 20 subjects".

Interview strategies

Stakeholder interviews can be classified by the amount and detail of preparation. On one side, there are structured interviews where each question has been pre-planned and where the interviewer will simply ask the questions and record the answers, without further elaborating on them. Structured interviews have the advantage that the gathered data can easily be aggregated and compared against each other (Gubrium & Holstein, 2002). Further, their rigid nature is more suitable in situations where there is a defined time window for the interview that cannot be exceeded. On the other side, there are unstructured interviews which do not follow any plan. Unstructured interviews have the advantage of developing like a natural conversation which can be more relaxing for the interviewee. Also, they give the interviewer the chance to elaborate on a given answer and extract as much information as possible. In-between structured and unstructured interviews are the semi-structured ones which try to incorporate the advantages of both interview types. Typically, semi-structured interviews follow a pre-planned list of questions but do give the interviewer some time to elaborate on the given answers if needed.

When conducting information gathering interviews, McBride (1986, p.84) proposed a semi-structured strategy where the interviewer prepares the questions before the interview but follows up with closed questions during the interview in case he or she requires more information or wishes to confirm an answer. This requires the interviewer to know what he or she is looking for. This can be achieved by continuously revisiting the records of previous interviews, allowing the interviewer to gradually establish a solid understanding of the key issues.

2.6.4. Heuristic evaluation

The section about heuristics evaluation in Nielsen’s & Mack’s (1994) book entitled *Usability inspections methods* is cited in almost every research paper on heuristics evaluation and can therefore be seen as a standard work on the subject. The authors advertise heuristics evaluation as a cheap usability evaluation method that is best applied at, but not limited to, early stages of design and implementation. The low cost of this method stems from the fact that it does not rely on users which, in many cases, need to be paid for. Also, this method can be applied by as few as one single evaluator. However, it needs to be noted that the authors suggest between two and five evaluators, depending on the desired quality of the outcome and the expertise of the evaluators. The recommended way of conducting the evaluation is by executing typical user tasks and assessing the system against a set of principles, called the ***heuristics***. Nielsen and Mack (1994) categorise ten high level heuristics as shown in Table 2.3. In order to provide a better understanding, a definition and an example referring to a possible clinical handover system are given for each heuristic. Note that the heuristics align with the usability aspects presented in section 2.4 of this literature review.

Table 2.3

Heuristics (Nielsen & Mack, 1994) (adapted by author)

Heuristic	Definition	Example (Clinical Handover System)
Visibility of system status	The system should keep the user informed about what it is doing.	Status information such as "Searching for patients, please wait".
Match between system and the real world	The system should speak the user's language.	Use the term "Body Mass Index" as opposed to "Quetelet Index" (alternative term for "Body Mass Index").
User control and freedom	Provide a "way out" if users went to wrong place.	If a patient can be expanded on, there should be a "return" button to return to the overview of all patients.
Consistency and standards	Be consistent throughout the system and follow standards.	Do not use the term "Women's Assessment Unit" on one page and "WAU" on another.
Error prevention	Prevent the user from doing errors.	For example, if an admission date needs to be entered, let the user choose the date from a calendar as opposed to enter it in a field (which could lead him or her to enter 30 February etc.)
Recognition rather than recall	Minimise the users memory load.	Having the NHI number of a patient displayed all the time so that the user does not need to note it down.
Flexibility and efficiency of use	Allow user to tailor system.	Let user adjust the print view so that their printout only contains the information they require for their job (a midwife might require other information than a house officer).
Aesthetic and minimalist design	Follow best practice design guidelines and avoid the display of irrelevant information.	Rather than presenting all medical staff information, filter out those people who are currently in charge.
Help users recognise, diagnose and recover from errors	Error messages should be in clear language and provide real help.	Error messages such as "The person with this NHI number is not currently admitted to this hospital" as opposed to "Error 5867: Database did not return information".
Help and documentation	Provide usable help documentation.	Provide a searchable section with frequently asked questions as opposed to a 100 page user guide.

After completion of the evaluation, the authors recommend to classify each usability problem found on a numeric scale. This should assist the designer and programmer in re-designing and programming of the code and address areas of most concern first.

In regards to the required domain knowledge of the system under evaluation, Pearrow (2007, p.4) states that although usability specialists have mostly a better understanding than a layperson, they do not need to be experts or have intimate knowledge of the system they evaluate.

2.6.5. Comparison between various usability evaluation methods

Various researchers (Tan, Liu & Bishu, 2009; Jeffries & Desurvire, 1992) conclude that each usability evaluation method has particular strengths and weaknesses. For instance, Nielsen and Mack (1994) assess the strength of heuristic evaluation in finding ‘false positive’ problems, i.e. issues that cannot be spotted by users during a short usability test but might manifest themselves over the long term. One such sample could be the misplaced navigational feature which has been mentioned in subsection 2.4.4. On the other hand, user observations help to overcome the ‘developer bias’ that project teams (including the evaluator) might have. In addition, Kanter and Rosenbaum (1997) mention that user observation is a great tool to capture the ‘actual user experience’. Table 2.4 shows a comparison of the four discussed usability evaluation methods and shows some of the strengths and weaknesses for each method.

Table 2.4

Comparison of usability evaluation methods

Method	Type	Strengths	Weaknesses
User observation	User based	Overcoming the 'developer bias' (Nielson & Mack, 1994)	Hawthorne Effect: Hyper-normal functioning of an individual under observation (Pearrow, 2007, p.66)
		Capture 'actual user experience' (Kanter & Rosenbaum, 1997).	If conducted in a laboratory: Lab environment does not duplicate the user's real environment (Pearrow, 2007, p.23)
		Can provide evidence that can be used to convince key decision makers (Pearrow, 2007, p.66)	
Survey	User based	Can be conducted anonymously, which can help in finding problems where users would otherwise blame themselves (Norman, 2002, p.35)	Users choose/provide the correct answers in an attempt to appear socially acceptable (Pearrow, 2007, p.72)
Stakeholder interview	User based	Allows to clarify observations made during the user observation (Manga, 2011)	Inaccurate assessment when removed from the context of use (Cooper, Reimann & Cronin, 2007, p.56)
			Not adequate for the level of insight required (Berg, 1999)
Heuristic evaluation	Expert based	Finding 'false positive' problems (Nielson & Mack, 1994)	If evaluator is part of the development team: Presence of 'developer bias' (Pearrow, 2007, p.73).
		More balanced between positive and negative usability aspects (Germaer, 2003).	

Since each method has its strengths and weaknesses, it is widely accepted that the various usability evaluation methods are complementary as opposed to competing. It is regarded as good practice to apply more than one method in order to “provide a broader base for specifying (usability) requirements” (Garmer et al., 2003).

2.6.6. General considerations about the application of usability evaluation methods

Buxton and Greenberg (2008) provide a critical review of the application of usability evaluation methods, both in research and practice. While generally agreeing with the value that such methods provide, they point to some issues that should be considered before such methods are blindly applied.

Firstly, while assessing usability, too much attention is paid to the rigorous application of usability evaluation methods, while very little attention is given to the subjective assessment of the usability expert. The authors argue that usability experts have, over the years, acquired a large amount of “tactic understanding” and hence, “the subjective arguments, opinions and reflections of experts should be considered just as legitimate as results derived from our more objective methods” (Buxton & Greenberg, 2008).

Secondly, usability evaluation methods focus too much on usability issues and neglect, or even completely omit usability successes. The reason is believed to lie in the fact that “cost (problems) is easier to measure than benefit (success)” (Buxton & Greenberg, 2008). Germaer (2003, p.90) argues that this focus on issues is even more distinct when applying methods that involve user-artefact interaction, such as user observation. This focus on issues could lead to a re-designed system where the sum of broken usability successes outweighs the sum of fixed usability issues. This will inevitably lead to poor user satisfaction, additional cycles of design and implementation or, at worst, an abandoned system.

2.7. Triangulation of methods

In science, triangulation refers to the mixing of multiple research methods in order to get two or three viewpoints on an issue. Also, triangulation means that the outcome of one method influences the application of another and vice verse.

In the field of usability, the concept of triangulation is well known and frequently applied. Manga (2011) proposes a usability evaluation process which uses questionnaire, user observation and interview executed in a serial manner. Under this approach, each previous method acts as an input for the subsequent one. For example, the questionnaire defines what actions the user is asked to perform during the user observation. Likewise, the user observations then highlight the questions which will be asked to the users in the interview phase.

2.8. Requirements engineering

Requirements are recorded descriptions of desired or mandated functional or non-functional aspects of a planned system or software. Usability related aspects are a subset of the non-functional requirements. Ideally, they specify “what” a system or software should do as opposed to “how” it should do it (Faulk, 1997). Requirements form an integral part of the system and software development process as they ensure that the requested product is being built and no additional or superfluous functions are added to it. The number of requirements and the way of requirement recording varies greatly between different projects and is dependent on many factors such as the size of the deliverable, complexity, work practices or geographic distribution of the project team. A small agile project may have only a set of hand written requirements while a large scale project could possibly have hundreds of requirements which are captured in a specialised tool. Requirements engineering can be split into four distinctive activities which are requirements elicitation, requirements analysis, requirements specification and requirements validation (Gottesdiener, 2008).

2.8.1. Requirements elicitation

According to Zowghi and Coulin (2005), the first step of the requirements engineering process requires the author to understand the application domain in order to have enough subject specific knowledge. This is followed by the identification and analysis of the requirement source(s), which are mostly human stakeholders of the proposed or updated system. Next, the author selects a suitable method and elicits the requirements. When selecting the method(s) for requirements elicitation, it must be understood that there is no single method suitable in all circumstances (Zowghi & Coulin, 2005). Rather, the choice of method(s) to be used is dependent on the specific context of the project and the type of requirements to be specified. As for usability requirements, it is often difficult to elicit them through the use of the often favoured method of stakeholder interviews. This lies in the nature of usability-related aspects of a system. Users are typically not aware of them until they are actually encountered. Even then, users might not be able to clearly specify them, resulting in broad statements such as “the system does not do what I want” or “the system is unusable”. In order to overcome this limitation, usability requirements elicitation should also apply some of the usability evaluation methods discussed in section 2.6 of this report. However, this necessitates the availability of a system - either a previous version of the system under development and/or a pilot version of the new system, which could be as basic as a handwritten sketch of the graphical user interface.

2.8.2. Requirements analysis

Requirements analysis is the process of extracting requirements from the data obtained through the application of the requirements elicitation methods discussed in the previous subsection. This is often achieved through the application of requirement models. Gottesdiener (2008) lists 29 different models that can be applied for the analysis of requirements. Among them is the model of personas. Personas are detailed descriptions of fictitious system users. The advantage of personas is to help the requirements author to “develop an understanding of our users goals in specific contexts” (Cooper, Reimann & Cronin, 2007, p.76)

2.8.3. Requirements specification

When specifying requirements, literature often suggests a multitude of factors that characterise good requirements. This subsection outlines some of the more frequently mentioned characteristics that well written and constructed requirements must possess.

- **Correct**

  A requirement needs to correctly specify the intent of the source. Often faced problems around the correctness of requirements are misunderstandings between requirements source (e.g. the business stakeholder) and requirements author (e.g. member of the project team) or the fact that requirements specification documents are only partially updated, leaving certain requirements in incorrect status. An example could be when the requirements source requests renaming of attributes but not all the requirements have been updated in that manner.

- **Atomic**

  Each requirement consists of one single element. Having multiple requirements within one statement can cause difficulties for the purpose of traceability in the case where the requirement has only been met partially.

- **Unambiguous** (e.g. Turk, 2006)
  Requirements should be unambiguous which means that they are interpreted by every reader in the same way with no room for variations. Therefore, terms like "fast" or "user-friendly" should be replaced by specific and meaningful alternatives such as "not more than 3 seconds" or "every page must be accessible from the menu on the homepage".
- **Consistent / Non-contradictory**
  Requirements should not contradict each other. This is relatively easy if there is only one source, but it gets increasingly difficult as the number of sources increases, demanding a lot of attention during the activity of requirement analysis.
- **Complete**
  Same as for 'non-contradictory', completeness is easy to achieve if there is only a single source for the requirements. An often faced issue around completeness is that a requirement source has not been identified during the activity of requirements elicitation, which could then lead the resulting software product being not usable or only partially usable for this particular source.
- **Ranked for importance**
  A large amount of software projects extend their initial allocated budget (Aurum & Wohlin, 2005, p.1). This could force the project to reduce the initial scope of the software in order to save money. In such a case, it is important to have ranked requirements so it can be established what feature to de-scope first.
- **Traceable: Requirements traceability**
  Traceability "follows a requirement as it "travels" through the hierarchy of the work breakdown structure to the project teams and eventually to the customer" (Kirova, Kirby, Kothari & Childress, 2008). It ensures that all demanded features and functions have been incorporated into the design as well as the resulting software and have been tested adequately. Also, requirement traceability highlights non-compliance at an early stage, helps to avoid the creation of non-demanded features and assists with the impact assessment in the case of requirements change.

- **Verifiable** (e.g. Turk, 2006)
  In order to ensure the quality and success of a product, it must be possible for each requirement to be verified through a test. This might be an executable test script or a static test such as a code audit.

2.8.4. Requirements validation

Once the requirements have been specified, they need to be validated by the source. This can be achieved by letting the source stakeholder review and approve them or by validating them through other means, for instance running them against "personas" that have been created as part of the requirements analysis activity. Requirements validation is not a single step at the end of the requirements engineering process but a continuing activity that can take place at any stage. This is backed by Turk (2006) who argues that "keeping users involved as requirements are developed and refined" is a key guideline for requirements development.

2.8.5. Benefits of good requirement engineering

The IEEE803 standard lists the expected benefits from good requirement engineering. They are the definition of a clear understanding between customer and supplier and reduced development effort when unambiguous guidelines are given to the developer. Further, well written requirements provide a basis for estimating costs and schedules, the development of test cases and for future enhancements and product transfers. Last but not least, good requirements significantly reduce software lifecycle cost as 80% of the post release cost is triggered by unmet, unseen or wrongly interpreted requirements (Pearrow, 2007, p.19).

Chapter 3. Methodology

This chapter of the thesis outlines the setting in which this research has been conducted (section 3.1), including a list of key constraints and assumptions that have been considered (section 3.2). This is followed by an explanation of the research framework (section 3.3) and a detailed description of how the four chosen usability evaluation methods have been applied in the context of this project (section 3.4). Finally, the author declares his domain knowledge in section 3.5.

3.1. Setting

This thesis used the opportunity of the Clinical Handover Improvement Project (CHIP) being run in the Women's Health Department at Auckland City Hospital (ACH), Auckland District Health Board (ADHB). The Department leadership have identified problems with clinical handover, and initiated CHIP in an attempt to reduce risk in this area. Dr. Victoria Carlson (one of the registrars in training) will be involved in the clinical assessment of the quality of the study, as part of her training requirement. One of the Senior Consultants, Dr. Emma Parry, and the quality manager for the department, Yvonne Kaepelli are leading this project, and strongly support the team approach to analysis of problems associated with handover and identification of solutions, and particularly welcome student involvement. Ethics approval was obtained from the Northern X Regional Ethics Committee (Reference number NTX/11/EXP/031).

3.1.1. Pre-intervention handover at delivery unit of Auckland City Hospital

The clinical handovers evaluated as part of this thesis are the doctors' handover at 08:00 and 22:00. These are the handovers of all patients at the Delivery Unit (DU) and Women's Assessment Unit (WAU). Women at the WAU who might get into labour shortly are called "inductions". In addition, other outlying patients that, due to their medical condition, might be admitted to the DU or WAU shortly are mentioned as well.

The primary attendants of the handovers are the incoming and outgoing Senior Medical Officers (SMO) and Resident Medical Officers (RMO) of the DU and WAU. However, outgoing SMO often delegate the responsibility to their RMO and do not attend the handover in person. Also, the handovers are attended by the Charge Midwife and other midwifes (who have a separate handover at the turn of their shifts) as well as the

Anaesthesiologist. The Charge Midwife is required to attend as she has a good understanding of the conditions of all patients in the DU, not only the ones that required the care of the SMO and RMOs. The Anaesthesiologist is required since she or he has to be aware of patients that might need to be admitted to the operating theatre and therefore need to be anaesthetised. However, it is understood that the anaesthesiologists believe that only a small subset of the given information is actually of value to them and that, as a result, they are only reluctantly attending the handover.

Environment

The physical environment where the handover takes place is the DU workroom which is located immediately behind the unit's reception. The room serves many purposes, with handover being one of them. As a result, the room is frequently shared with other people at the time of the handover, leading to a certain level of disturbance.

Process

While there is no formal process for the handover, initial observations have showed that it loosely follows an informal process. Firstly, the outgoing shift hands over the patients at the DU, using the electronic whiteboard application to recall the status for each patient and ensure that no patient gets forgotten. SMOs and/or RMOs hand over patients that have required their care during the previous shift. The remaining patients seem often to be handed over by the Charge Midwife in a much more summarised way. The incoming shift tends to use a printout of the electronic whiteboard application and write additional information on it if needed (which seems to be the case more often than not). After handing over the patients at the DU, the team switches over to the patients at the WAU who are handed over in a similar manner. Finally, there is a brief mention of the outlying patients (patients in other wards that might be admitted to DU or WAU). In terms of quantity and quality of information handed over for each patient, there is no indication that this follows any process at all. This seems to be entirely at the discretion of the medical staff handing over the patient.

System

In terms of IT system support, the handover makes use of an electronic whiteboard application called CHIPS (CMS Hospital Integrated Patient System). It was developed in 1997 in order to address the need for a system that can display relevant patient information to medical staff. It consists of a graphical user interface which closely resembles applications such as Microsoft Excel, where patient information is presented in a grid layout. Further, patients can be recorded on multiple spreadsheets (e.g. split by ward). The data is grouped by rooms and each row holds information for one particular patient. The type of information displayed or to be entered is loosely given by the headers of the columns (e.g. Patient Name, NHI Number, Age, Midwife, Comment, Diet etc.). Some of the data fields are pre-populated from another system and non-editable (e.g. Patient Name or NHI number). Other fields are editable free-text fields (e.g. Midwife or Plan) while some of the fields are presented to the user as a drop-down menu with options to choose from (e.g. Case Manger or Anaesthesiologist). For the free-text fields, there is no enforcement to enter information, no verification or limitation of the information to be entered, nor a deletion protection for data entered previously. The electronic whiteboard application does not have its own database. Instead, all the data is retrieved from and written to Auckland District Health Boards central database system, called CMS. The amount and order of information displayed on the electronic whiteboard can be customised for each spreadsheet by the system administrator. In contrary, the main menu of the application is fairly static in order to allow for a consistent user experience. The electronic whiteboard application offers its users two printout options: one for printing the whole screen (including menu items) and one for printing the patient information in the whiteboard (i.e. grid) only. Figure 3.1 shows a screenshot of the electronic whiteboard of the initial handover system (for patient confidentiality, the patient names and their NHI numbers have been blacked out).

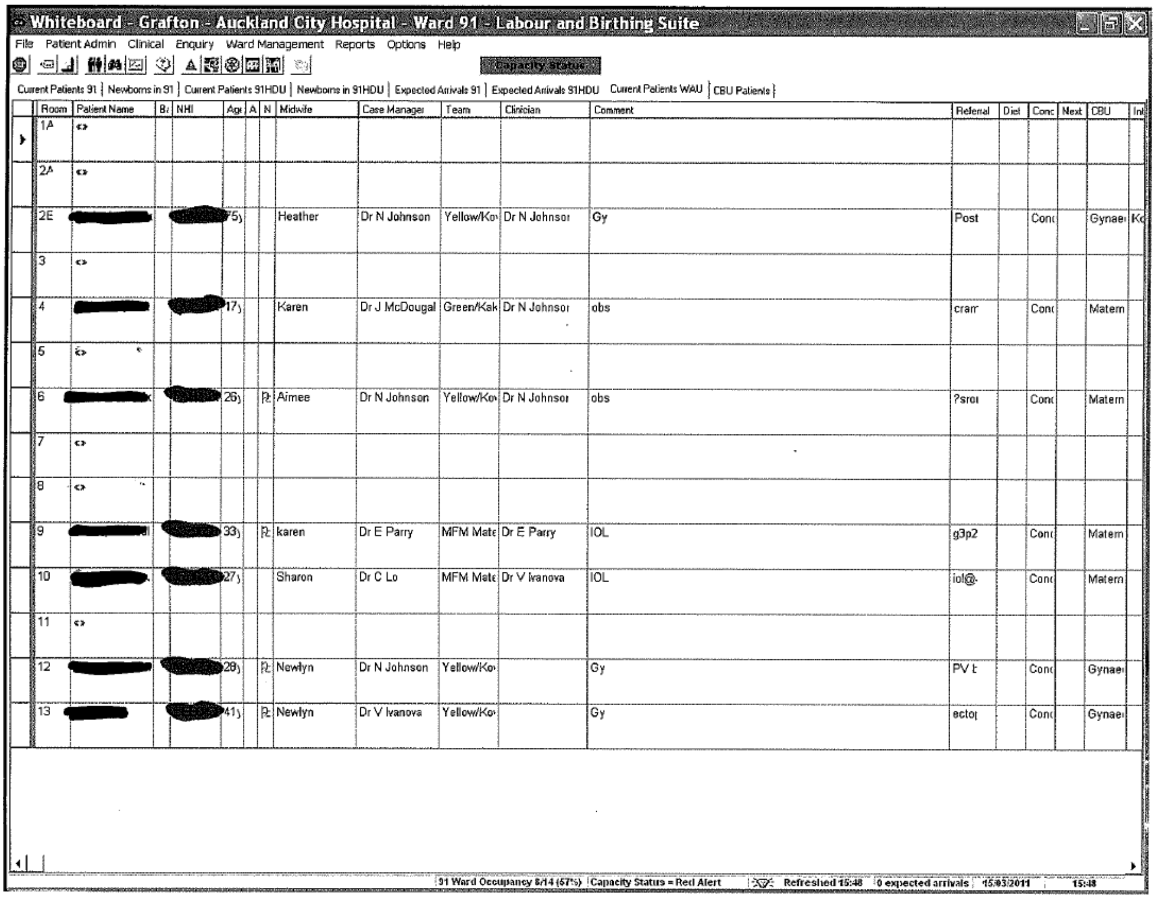

Figure 3.1. **Screenshot of the initial handover system (electronic whiteboard)**

3.1.2. Participants at the handover

Table 3.1 shows the positions of people who either regularly attend the handover at the Women's Health Department or might occasionally attend it.

Table 3.1

Roles at Auckland City Hospital / Women's Health Department

Abbreviation	Role Name	Role Description
SMO	Senior Medical Officer	Senior doctor. Can be a public servant (PS) or private (PR). They either specialise in Obstetrics and gynaecology (O&G) or Anaesthetics (AN). SMOs are also called "Consultants".
REG	Registrar	Junior doctor (Resident Medical Officer - RMO). They either specialise in Obstetrics and gynaecology (O&G) or Anaesthetics (AN). More senior than SHO. Is public servant (PS).
SHO	Senior House Officer	Junior doctor (Resident Medical Officer - RMO). They either specialise in Obstetrics and gynaecology (O&G) or Anaesthetics (AN). More senior than HO. Is public servant (PS).
HO	House Officer	Junior doctor (Resident Medical Officer - RMO). They either specialise in Obstetrics and gynaecology (O&G) or Anaesthetics (AN). Is public servant (PS).
n/a	Student / Trainee	Person who studies to become a doctor.
CCM	Critical Care Midwife	Midwifes. Can be public servant (PS) or private (PR).
CM	Charge Midwife	
n/a	Midwife	
OTC	Operating Theatre Coordinator	Person who assigns Patients to the Operating Theatre.
LMC	Lead Maternity Carer	Person who brings patient to the hospital. Can be SMO or Midwife, Public (PS) servant or private (PR).

Notes:

- Although senior and junior doctors specialise in obstetrics and gynaecology (O&G), their role at the handover will be either obstetrician (if presently working at the DU) or gynaecologist (if presently working at the WAU)

3.1.3. CHIP Project

The CHIP Project attempts to improve the quality of the current handover by the application of various changes. At a high level, the changes can be grouped into three distinctive categories: ***environment***, ***process*** and ***system***. They are explained below.

Environment

Firstly, the CHIP project has improved the environment for the handover. This included the movement of the handover into a dedicated room and the use of a large wall mounted monitor. Figure 3.2 and Figure 3.2 below show the environmental changes implemented by the CHIP project.

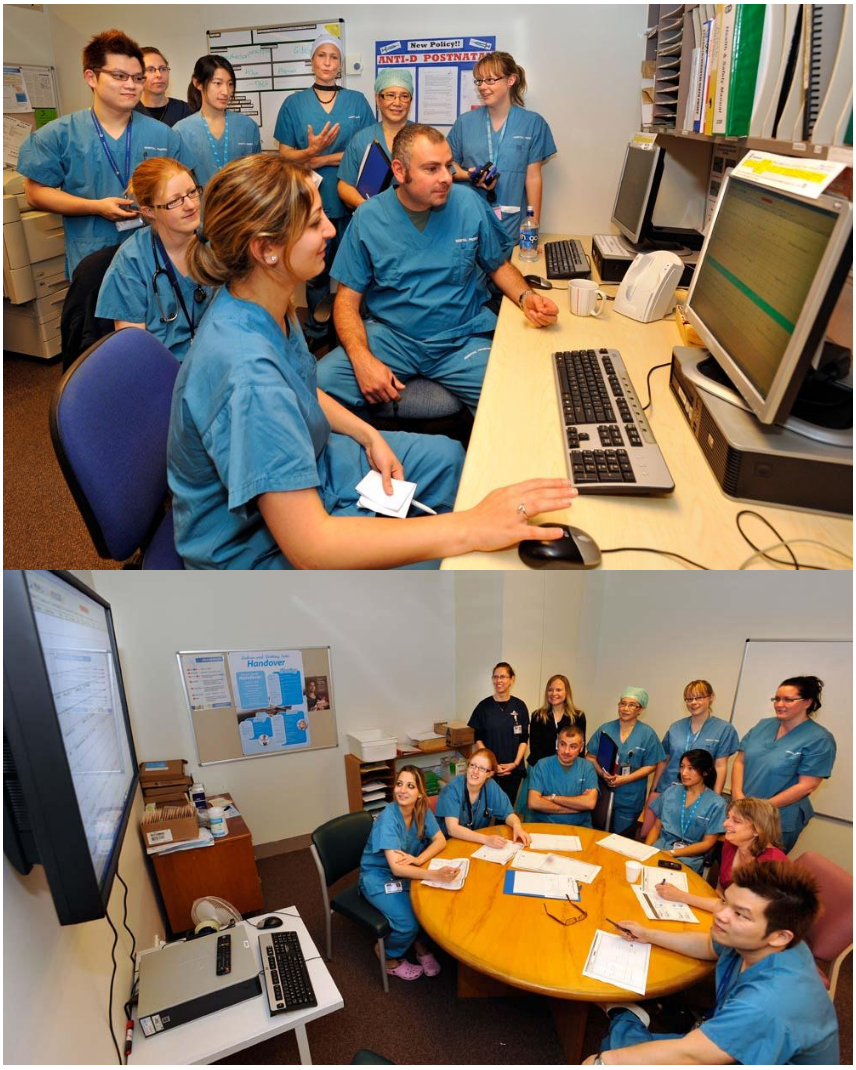

Figure 3.2. **Handover environment: initial (top) and improved (bottom)**

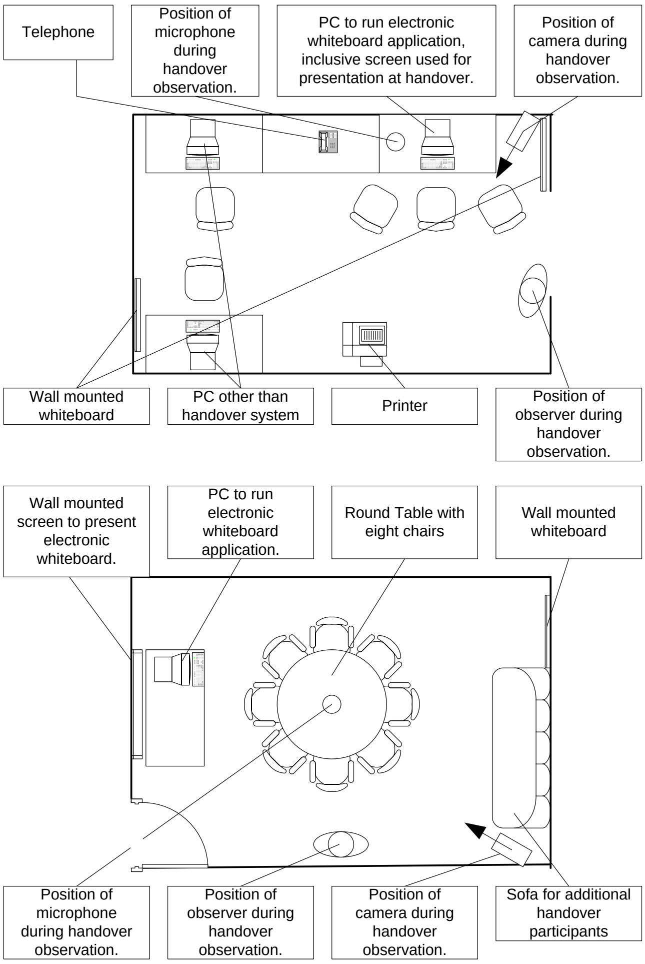

Figure 3.3. **Floorplan of the handover environment: initial (top) and improved (bottom)**

Process

Secondly, the introduction of a standardised process (called SHARING) aims to ensure that the handover is conducted in a structured manner and that none of the required activities gets omitted. SHARING is a mnemonic and each letter stands for a core activity of the handover process. Part of the SHARING process is the handover of each individual patient, which again follows a sub-process that is summarised by another mnemonic: IBAAAR. IBAAAR stands for Identification, Background, Alerts, Analgesia, Assessment and Recommendation. The use of IBAAAR ensures that the minimum dataset for each patient is handed over from the outgoing to the incoming shift. Both, SHARING and IBAAAR are explained in Table 3.2 and are alterations of the processes suggested by the Australian Commission on Safety and Quality in Health Care (2010) (see subsection 2.1.4).

Table 3.2

CHIP handover process

Process for Overall Handover - SHARING		
S	Staffing	Updated about staffing by using existing whiteboard
H	High Risk	Handover of High Risk patients using IBAAAR
A	Awaiting OT	Patients who have to go to Operating Theatre
R	Recovery/OT	Patients who come from the Operating Theatre
I	Inductions	Handover of patients from WAU who are getting into labour using IBAAAR
N	NICCU	Open/closed Bed status
G	Gynaecology	Handover of patients from WAU (except inductions) using IBAAAR
Process for individual Patient Handover - IBAAAR		
I	Identification	Room, Name, NHI number etc.
B	Background	BMI, Parity, Gestation, Past Obstetric History, Medical Conditions, Medications etc.
A	Alerts	Antibodies, Allergies, Social Issues, Psychiatric issues etc.
A	Analgesia	Anaesthetic concerns
A	Assessment	Reason for admission, relevant bloods / investigations, Observations etc.
R	Recommen-dations	Planned Management, Next review assessment, relevant teams informed.

A laminated card, explaining the SHARING and IBAAAR mnemonic has been given to all the handover participants for reference.

System

The CHIP project has also implemented limited improvements to the electronic whiteboard application used for the handover (see subsection 3.1.1). However, a major enhancement of the electronic whiteboard, which could include entry checks or separate expandable views for each patient, was not in scope for the CHIP project. This was due to the fact that such an extensive enhancement could not be designed, developed, tested and implemented in the timeframe given for the project. Hence, the project limited itself to the customisations that are possible for the administrator of the current system.

Figure 3.4 shows a screenshot of the electronic whiteboard of the improved handover system (for patient confidentiality, the patient names and their NHI numbers have been blacked out).

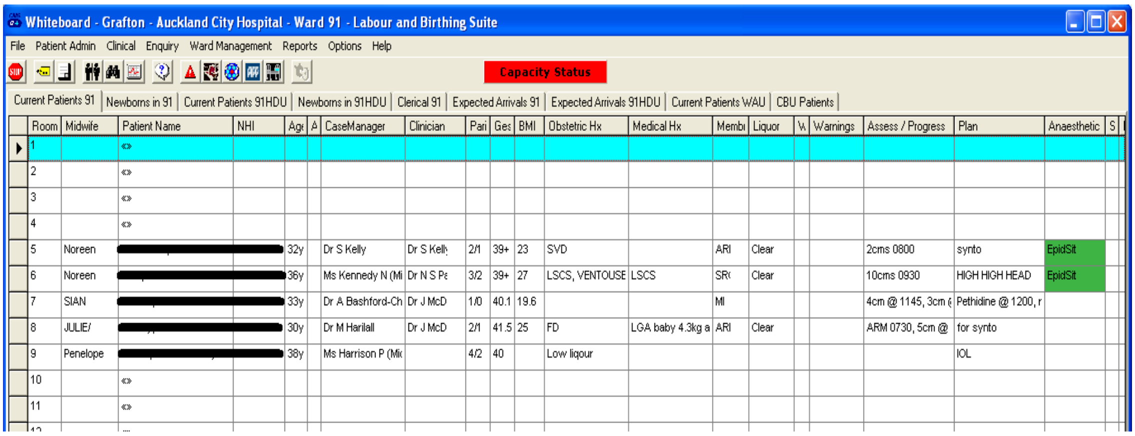

Figure 3.4. **Screenshot of the improved handover system (electronic whiteboard)**

The above mentioned environment, process and system changes were implemented by the CHIP Project in early June 2011, leading to an updated and improved handover environment (see Figure 3.5, E2). This coincided with a new roll of registrars who started work at the Women's Health Department at the same time. The medical staff were trained on the SHARING and IBAAAR processes at the Continuing Medical Education (CME) meeting on the 10 May 2011, just before the updated system was rolled out.

In addition to changes outlined above, the CHIP project also measured the success of the applied changes by the execution of two evaluations, one in the initial and the other in the updated handover environment. The applied methods during the evaluation were user observation and a survey (see Figure 3.5, M1 and M2). While the user observations main intent was to measure and compare the quantity and quality of the handed over patient information, the survey provided data about areas such as user satisfaction and process awareness. The timing and intent of the CHIP project was such that the usability evaluation served as a tool to provide data for analysis and comparison and not in order to inform the applied changes to the handover environment, process and system (these were largely decided upon by the start of the first evaluation). However, some of the early findings might have marginally informed the changes.

Figure 3.5 shows and overview of the activities conducted by the CHIP project.

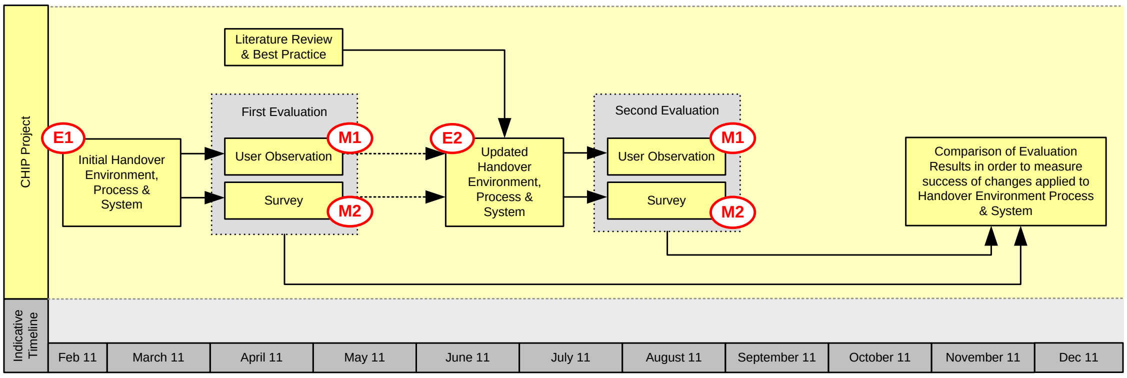

Figure 3.5. **Overview of CHIP Project**

3.1.4. Thesis

This study used the opportunity provided by the CHIP project in order to apply two sets of usability evaluation. The first one was conducted in the initial handover environment, prior to the environment, process and system related changes introduced by the CHIP project (see subsection 3.1.3). The second one was conducted in the updated handover environment, two months after the implementation of the changes. Each usability evaluation utilised a set of four usability or usability-inspired research methods (see Figure 3.6, M1-M4) which produced a large amount of raw data. This raw data went through a subsequent process of data analysis and interpretation, resulting in two lists of usability events (see Figure 3.6, L1&L2). A usability event, as defined in subsection 2.3.2, is an occurrence or feature that impacts the usability of an artefact in a positive or negative sense. The first list of usability events also informed the practical application of the usability methods during the second usability evaluation, while the second list assisted in the formulation of usability design requirements. These usability design requirements, which form the main deliverable of this thesis, can then be used by practitioners in order to improve the clinical handovers and create a future handover environment, process and/or system. However, the creation of a future handover system does not form part of this thesis.

Figure 3.6 shows an overview over the activities conducted during the thesis. The choice of framework and methods, as well as the deliverables (List of usability events and usability design requirements) will be discussed in section 3.3.

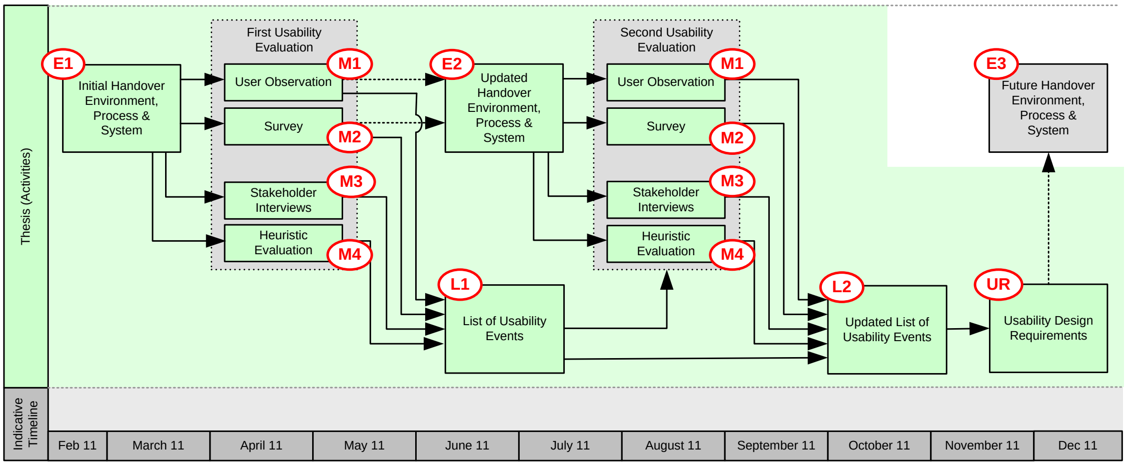

Figure 3.6. **Overview of study**

3.1.5. Alignment between CHIP Project and thesis

Figure 3.7 shows an overlap of Figure 3.6 and Figure 3.5, summarising all activities conducted by the CHIP project and during this research. This overview is also the basis for the research framework discussed in section 3.3.

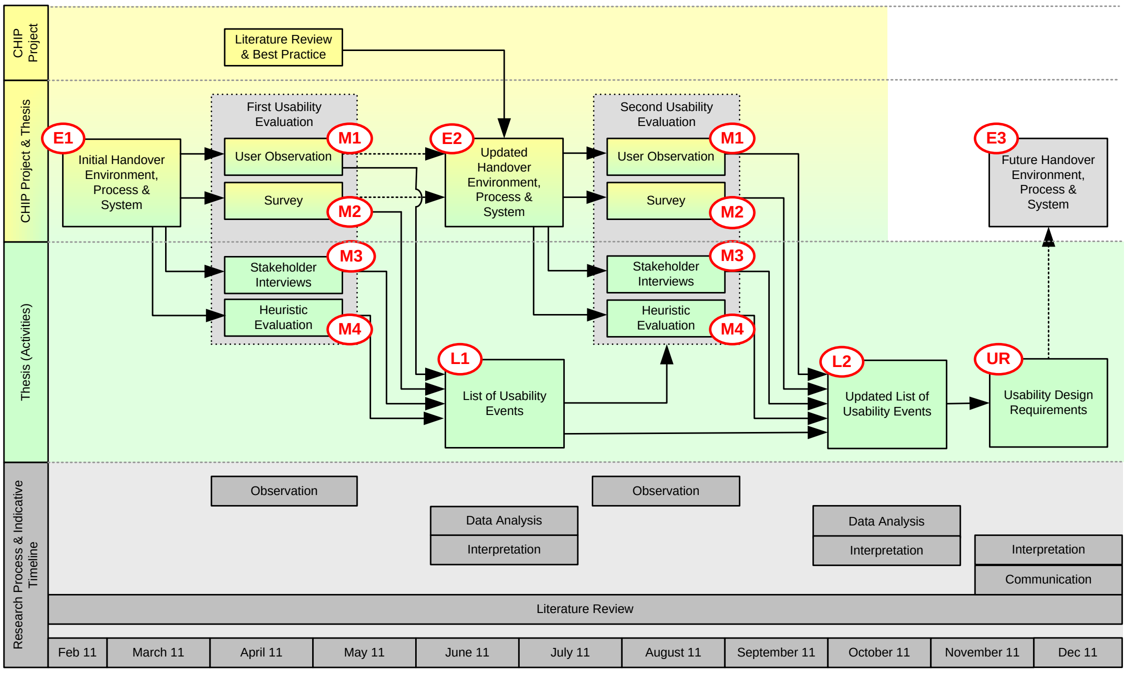

Figure 3.7. **Alignment between CHIP Project and study**

As evident in Figure 3.7, there are several overlapping activities and interdependencies between the CHIP project and this study.

Firstly, the activities that formed this study needed to align with the schedule as well as the practical application of the evaluation methods used by the CHIP project, which were in turn linked to the availability of the initial and updated handover environment, processes and systems (E1 & E2).

Secondly, both the CHIP project and this study made use of the same user observations and surveys as their evaluation method. However, while the gathered raw data was the same, the data analysis and interpretation activities were conducted separately with very different purposes. As for the thesis, the raw data has been analysed in a usability inspired way, with the aim of extracting usability events.

3.2. Constraints and assumptions

Given the setting outlined in the previous section, there were various resulting constraints that applied for this study. These constraints needed to be addressed by the choice of an appropriate framework and the application of suitable research methods.

Constraint 1: "Real world" character of CHIP project

The "real world" character of the CHIP project and of this study did heavily influence the choice and practical application of the selected usability evaluation methods. For instance, it was not possible to conduct user observations that were followed by interviews, going through the video recording with the participant(s).This was due to the fact that the incoming shift had to commence work immediately after the handover while the outgoing shift (if attending the handover at all) was – understandably – very keen to get home after a long night or day shift. For the same reason there were only limited opportunities to conduct stakeholder interviews. This resulted in the fact that it was not possible to discover the true, "non-clinical" user goals (e.g. "I want to go home and forget about my work"). Hence, only the clinical goals (e.g. handover of all the necessary information for each patient) are considered in this thesis. Further, the thesis applied an expert-based usability evaluation method (heuristic evaluation) in order to overcome the somewhat limited access to users and to mitigate the constraint. The resulting choice and application of methods is discussed in section 3.4.

Constraint 2: Amount of available raw data

The amount of raw data produced during the usability evaluation was very large. For instance, the twenty video recordings during the user observation produced approximately ten hours of video. Therefore, it was expected that some minor and/or infrequent usability events would be overlooked by the application of a single usability evaluation method. As a result, a framework that supported the process of triangulation (e.g. confirmation of observations through the application of various usability evaluation methods, such as stakeholder interviews) has been adopted. It was hoped that this process would ensure that the observed issues were valid and that none of the significant issues (i.e. obvious usability issues) got omitted, leading to a measurable level of data saturation. The applied framework is discussed in section 3.3.

Constraint 3: Alignment between thesis and CHIP project

At the beginning of this study, the CHIP Project was already in an advanced state. Based on literature review and best practice, the CHIP project had already decided upon the changes to the initial handover environment, processes and system. Therefore, the observations of the first usability evaluation could not directly influence any change and, as a result, no usability design requirements were written at that stage. However, the findings of the first evaluation helped to inform the second one and the second evaluation led to the creation of usability design requirements that can be used for a future enhancement of the handover system at Auckland City Hospital as well as for enhancements of clinical handover systems elsewhere. The applied framework is discussed in section 3.3.

Constraint 4: Usability specialist is not domain expert

The usability expert who conducts the usability evaluation for this study does not possess any knowledge in regards to clinical handover procedure and/or the detail of the information being handed over. The author's level of domain knowledge is declared in section 3.5.

Constraint 5: "Hawthorne effect"

The second round of usability evaluation was conducted relatively shortly (i.e. eight weeks) after changes had been applied to the handover environment, process and system. As a result, there might have been a "Hawthorne effect" (i.e. change of environment leading to better performance).

Assumption: Usage of future handover system

The first few user observations on the initial handover system provided strong evidence that there were three distinctive user personas in regards to the use of the handover system as their working surface during the handover. These were:

- Persona 1: Non-users (log examples: Appendix A, 07/02:51 & 08/01:51), i.e. users who do not use the handover system at all. The primary working surfaces are either notes or none (i.e. handover based entirely on recalled information). Non-users are typically turned away from the handover system.
- Persona 2: Handover system is used as auxiliary working surface (log examples: Appendix A, 03/09:15 & 09/25:36). These users refer to the handover system in order to provide a list of patients that need to be addressed or to refer to information that has not been noted down or cannot be recalled. However, the primary working surfaces are either notes or none (i.e. handover based entirely on recalled information). Users with this type of persona are typically turned away from the handover system and turn to its screen only sporadically.
- Persona 3: Handover system is used as primary working surface (log examples: Appendix A, 08/12:05 & 09/06:15). These users read all or most of patient information from the screen of the handover system and also update the information in the system if needed. They typically face the screen of the handover system.

This thesis focuses on the formulation of usability design requirements for the user persona who uses the handover system as their primary working surface (primary users). This approach of prioritising user personas aligns with Cooper, Reimann and Cronin (2007, p.104) who argue that the creation of a system that meets the needs of various personas can be an overwhelming task. They therefore suggest prioritising identified user personas. As discussed above, persona 2 is regarded as a secondary user of the handover system. Further, a goal of this thesis is to create usability design requirements that lead to a handover system that encourages persona 1 and persona 2 to use it as their primary working surface. The shift towards persona 3 is expected to be noticeable in an improved handover system.

3.3. Applied framework

Figure 3.7 in subsection 3.1.5 shows the alignment between the CHIP project and this study, clearly outlining the main activities of the CHIP project (yellow background) that partially governed the sequence of activities conducted during this research (green background). This interdependency between CHIP project and the study (constraint 3), as well as the fact that the research was conducted in a "real world" environment (constraint 1) demanded the choice of a flexible framework, allowing for adjustability and frequent changes.

However, in order to be accepted by the scientific community as genuine research, the chosen framework for this research project must also align with the basic principles of clarity, reproducibility and disclosure (Graziano & Raulin 1993, p.38). That in turn demands a more rigid framework, adhering to a research process with clearly defined phases of activities.

The marriage between the conflicting requirements of flexibility and rigidity has been achieved as explained below.

Flexibility: Triangulation of methods chosen in response to emergent need of the project

In order to evaluate the clinical handover at Auckland City Hospital, this research project applied a multitude of usability evaluation methods that have been chosen in response to the emergent need of the project. The chosen methods were either ones that are used predominantly in the filed of usability or commonly used methods that have been applied in a "usability inspired way". The choice for the application of multiple usability evaluation methods (as opposed to one) was due to three reasons.

Firstly, the outcome of multiple methods allows for the application of a triangulation process (Westbrook et al., 2007), which is expected to provide more accurate results.

Secondly, as outlined in the literature review (see subsection 2.6.5), each usability evaluation method has its strengths and weaknesses. This is further supported by Mingers (2001, p. 244) who argues that "each [method] reveals certain aspects, but is blind to others" and that information science is very much a practical discipline and hence, the strict definition of a single method is not practicable. He therefore suggests the application of a multitude of methods that are chosen in response to the emergent need of a project (Mingers, 2001).

Lastly, as outlined in constraint 1 (see section 3.2), due to the “real world” character of this study, the access to users was limited at times. Hence, the application of only user based evaluation methods was not possible and the use of expert based approaches (i.e. heuristic evaluation) was required.

Rigidity: Linkage to research process

In order to allow for the principles of clarity, reproducibility and disclosure, Graziano and Raulin (1993, p.45) propose a seven step sequential research process, with each step representing one core research activity to be undertaken during a research project. In addition, the process is intended to assist the researchers by providing a basic structure to guide them through their work. This thesis makes use of this seven step process, by clearly linking research activities to corresponding project activities. However, due to the required flexibility, some activities are either conducted in parallel and/or multiple times as opposed to sequential.

Figure 3.8 shows the research framework, showing the application of flexibility through triangulation of methods chosen in response to the emergent need of the project (red) and the introduction of rigidity through linkage to research process (blue).

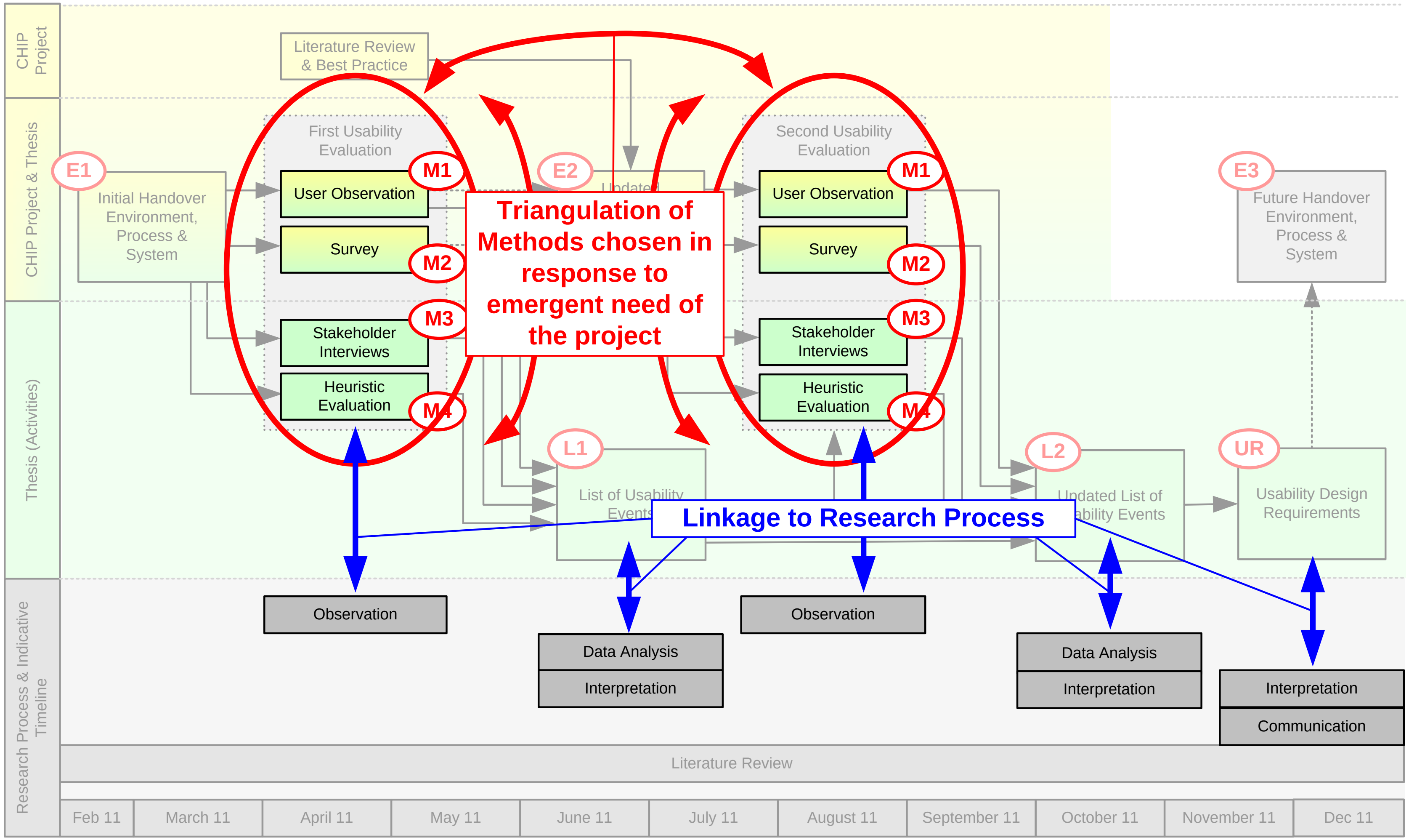

Figure 3.8. **Research framework**

3.4. Applied methods for observation (usability evaluation)

The chosen usability evaluation methods and their application were as follow:

3.4.1. Method 1: User observation (M1)

Ten user observations have been conducted in the initial as well as in the updated handover environment. The procedure was informed by literature (see subsection 2.6.1) and two pilot observations. Due to the real world character of the environment (see constraint 1 in section 3.2) and researcher's lack of subject specific knowledge (i.e. medical knowledge), the chosen evaluator role was the one of an "onlooker". This meant that there was no direct interaction with the participants during use (e.g. no application of the "think aloud" technique). Due to the discussed advantages of video recording (see subsection 2.6.1), all observed handovers have been recorded on video. The two pilot observations have been recorded through a video camera provided by AUT University, the subsequent ones through a camera that was temporarily installed by the Auckland City Hospital IT Department in the handover environment. The choice for the equipment provided by the hospital's IT department was based on convenience as opposed to technical reasons. The recording of the handover also meant that the evaluator did not necessarily have to attend in person. However, the handovers were attended in person whenever practically possible as this allowed for the recording of additional observations that were outside the angle of the video camera (e.g. events that occurred on the screen of the handover system or reactions of participants in the background and were not visible on the video).

3.4.2. Method 2: Survey (M2)

A written survey was conducted by Dr Victoria Carlsen pre- and post-intervention (i.e. before and after the change of the handover environment, process and system). The survey was handed out to the participants immediately after the handover and consisted of 13 questions which addressed the areas "information transfer", "environment", "process" and "handover system". Participants could enter their answers by placing a cross on a 10cm visual analogue scale where the two ends of the scale represented the opposite answer possibilities (e.g. Always vs. Never). The survey questions are shown in Table 3.3 below.

Table 3.3

Questions asked in the survey

Survey		
Question	Answer scale	
	From	To
1) Are Delivery Unit/WA handovers run effectively?	Very Effective	Not Effective
2) Is all essential information on patients handed over?	Always	Never
3) Is patient safety compromised by the current handover process?	Uncompromised	Compromised
4) During handover do you know the other members of the team?	Always	Never
5) Is the current environment where handover takes place, the DU workroom, appropriate?	Inappropriate	Appropriate
6) Would changing the environment help improve the handover process?	Helpful	Not Helpful
7) Is the current electronic whiteboard useful for handover?	Not Useful	Very Useful
8) Is the data on the electronic whiteboard relevant to handover?	Relevant	Not Relevant
9) Do doctors currently handover in a systematic and organised manner?	Organised	Disorganised
10) Would a pro forma be useful for DU/WAU handovers?	Very useful	Not Useful
11) Are outliers appropriately handed over?	Always	Never
12) Who should attend handover?	No scale. List of eleven roles that could be circled.	
13) Please add any comments regarding handover if you wish.	No scale. Empty space for comments.	

While the survey was conducted by the CHIP programme and the questions had been tailored towards the aim of measuring the effectiveness of the applied changes, the collected data could still give valuable hints in regards to usability and therefore assist in the process of triangulation.

3.4.3. Method 3: Stakeholder interviews (M3)

A set of semi-structured stakeholder interviews was conducted with various handover participants. The aim was to interview at least one participant from each role (see subsection 3.1.2 for the types of roles). The question asked at the interviews were the 11 questions suggested by the Australian Commission on Safety and Quality in Health Care (2010, p.22, section 1-3) for the “Organisational Leadership” phase of a handover improvement project. One additional question was added that particularly referred to the patient spreadsheet of the initial/updated handover system. The need for the additional question was realised after the pilot stakeholder interview as the 11 existing questions did not address specific information about the current/updated handover system. For that purpose, a printout of the handover system spreadsheet was taken to the stakeholder interviews. Since interview participation was on a voluntary basis and outside working hours (see constraint 1 in section 3.2), it was crucial to keep the interview duration in the range of 5-10 minutes. This was achieved by choosing a semi-structured interview style that was restricted to the 11+1 questions and by tape-recording the interviews, which did not require the interviewer to take notes and also allowed for later transcript and analysis. Also, enquiries were kept to a minimum and were only used in case where it was absolutely necessary in order to understand the given answer. The interview questions are shown in Table 3.4 below.

Table 3.4

Questions asked at the stakeholder interview

Stakeholder Interview
Question
1.1) What is your definition of clinical handover?
1.2) What are the functions of clinical handover?
1.3) What do you think the transferring of responsibility and accountability during handover means?
2.1) Can you please discuss how handover is currently conducted in your department?
2.2) What do you think are the positive aspects of your current handover process?
2.3) What do you think are the negative aspects of your current handover process?
2.4) How do you think your current handover process could be improved?
2.5) What information do you require for continuity of patient care during your shift?
2.6) How could information technology help you with handover?
3.1) How did you learn how to do handover?
3.2) How do you think handover should be taught?
4) How could the current spreadsheet be improved?

3.4.4. Method 4: Heuristic evaluation (M4)

A heuristic evaluation was conducted on the handover system pre- and post-intervention (i.e. before and after the application of changes to the display of the handover system). The application of a heuristic evaluation, which is an expert-based usability evaluation method, was important as it complemented the three previously mentioned user-based methods and compensated for the fact that user access was limited at times (see Constraint 1 in section 3.2).

The preparation of the heuristic evaluation followed a two-step process. In the first step, a list of typical user tasks was created. The tasks on that list were chosen based on the author's observation of users and stakeholder interviews. Further, the tasks were chosen to reflect the actions of two types of user personas that could interact with the system; persona 2, who uses the handover system as an auxiliary working surface, and persona 3 who uses the handover system as the primary working surface (see section 3.2, Assumption 1). The list of tasks is shown in Table 3.5.

Table 3.5

Tasks for heuristic evaluation

User Tasks on Handover System	
#	Task Description
1	Outgoing shift: Enter the relevant information for a patient into the handover system in preparation for the handover.
2	Incoming shift: Print the current list of patients in preparation for the handover.
3	Handover patient using the IBAAAR proforma. Use the handover system as well as notes taken on paper and/or printout of the handover system.
4	Handover patient using the IBAAAR proforma. Primarily use the handover system in order to achieve this task.

The second step involved the creation of a usability checklist of items to be verified during the heuristic evaluation. These selection of these items was informed by the ***best usability practices*** learned during the literature review (see section 2.3) as well as by specific usability-related concepts that the author has become aware of during the application of the three other usability evaluation methods. Hence, the concept of triangulation of methods came into play where the outcome of one method influences the application of another method and vice versa.

The subsequent execution of the heuristic evaluation was conducted in two phases. In the first phase, the evaluator executed each of the user tasks identified on the task list. Notes were taken whenever there was a violation of the ten heuristic principles provided by Nielsen and Mack (1994) (see Table 2.3). This ensured a process focussed assessment.

The second phase was a free-reign use of the system where the evaluator specifically targeted the items on the usability checklist that had been created before the heuristic evaluation. Again, notes were taken for each observation.

Note that due to the alignment between this study and the CHIP project (see section 3.2, constraint 3), the CHIP project had already implemented the changes to the handover system at an early stage. Hence, the pre-intervention heuristic evaluation on the initial handover system could only be executed on printouts of the graphical user interface that were provided by the CHIP project. However, due to the fact that the CHIP project only implemented changes to the display of the data (see subsection 3.1.3), this did not provide an impact of the rigour and quality of the heuristic evaluation.

The outcome of the heuristic evaluation can be found in Appendix C.

3.5. Declaration of author's domain knowledge

When the author undertook this research, he already possessed the following level of domain knowledge:

- Usability evaluation: Previous knowledge gained through ten years of IT related work experience with seven years in various testing positions (Tester, Test Manager, Test Director). Within these positions, the usability of several artefacts (mostly application interfaces) has been evaluated. Further, the author acquired usability evaluation knowledge through formal education. This included a Bachelor thesis at the University of Applied Sciences Northwestern Switzerland where, as part of the thesis, the usability of an IP-Centrex system has been assessed through heuristic evaluation. Also, the author conducted user-based usability evaluations as part of the "Usage Centred Design" (408204) and "Research Methods 1" (408220) courses that he studied as part of the Masters Programme at Auckland University of Technology.
- Medical: The author did not have any previous medical domain knowledge apart from what can be considered general knowledge.

Chapter 4. Data Analysis

In order to assist in the processing of the data, Groves et al. (2004, p.303) suggest various ‘post-collection processing activities’. The activities undertaken in this project and discussed in this section of the report are data coding (section 4.1) and data editing (section 4.2).

4.1. Data coding

According to Walliman (2001), “the development of a coding system is an important aspect of forming typologies, as it facilitates the organisation of [raw] data and provides a first step in conceptualisation” (p. 262). Therefore, the vast amount of raw data collected through the application of the four chosen usability evaluation methods has been coded as described below.

4.1.1. User observation

The 22 user observations resulted in a large quantity of raw video data. In order to work with the data, a user observation log file was created for each video file. Therefore, each video file was viewed and logs were taken whenever an incident occurred that was perceived as significant in regards to usability, either in a negative or positive sense. Incidents either manifested themselves the first time during the viewing of the video file or were “known” ones that have been identified from one or more of the following sources:

- Incidents observed during the creation of log files for previously coded videos.
- Incidents that became evident during the application of the other three chosen usability evaluation methods (i.e. application of triangulation of methods).
- Incidents that were learned from the literature review on usability aspects (see section 2.4).

In order to increase the efficiency of log taking, the above mentioned three sources were reviewed before the coding of each video file.

The log files were structured in a chronological order as shown in the example in Table 4.1. For each log, the following data was recorded:

- Identification of the log. This unique identifier included both a reference to the particular point in the video file and a reference to the incident for the purpose of this report. It consisted of the following two elements:
  a) Number of log file (in the example shown in Table 4.1, this is the log file for the 15th observation)
  b) Video timestamp (where an incident has been learned from the video observation) *OR* alphabetic identifier (where an incident has been learned from personal observation).
- Type of observation. This column indicates whether the incident has been learned from video observation (VO), personal observation at the handover (PO) or from both sources (VPO).
- Observation / Comment. Detailed description of the usability related incident.

While most logs referred to usability related incidents, some logs served an administrative purpose, e.g. to record the exact time the handover stopped.

Table 4.1

User observation log (example)

Handover Observation - 7-September 2011 / 08:00-08:17 / File 7 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
15/00:50	VO	Mention that representative operating theatre and charge midwife are not present at the handover.
15/a	PO	Seven out of eight people sitting at the table have a printout of the handover system in front of them.
15/03:40	VO	Person who hands over is pointing at the screen of the handover system.
15/05:34	VPO	Person enters data into the handover system.
15/05:48	VO	All eight persons sitting on the table look at the screen of the handover system.
15/08:30	PO	Outlying patient do not seem to be recorded in the handover system.
15/08:42	VO	Person doing the handover is asked to speak up.
15/09:02	PO	The information about a patient is read from a printout that is NOT the printout from the handover system.
15/10:36	PO	The spreadsheet of the handover system is changed.
15/10:46	VPO	Person interrupts the handover in order to discuss a patient of concern.

A summary of the findings from the user observations can be found in section 5.1. The log files for each user observation can be found in Appendix A.

4.1.2. Survey

For the survey, the participants were asked to answer each question by drawing a line on a 10cm visual analogue scale from 0 to 10 where the two ends represented opposite answer possibilities (e.g. 0 for "always" and 10 for "never"). Therefore, overall numeric values could easily be extracted by measuring and adding up the answers for each question. The results for each question were provided to the researcher in raw form by Dr Victoria Carlson from the CHIP project who conducted the survey.

In order to analyse the data, the following items of information have been captured for each question:

- Question: The question asked at the survey

- Answer scale. The two opposite answer possibilities given to the participants for each question.
- Number of replies for both pre-change survey and post-change survey. This gave an understanding whether a score change was based on the same population size and therefore could be regarded as representative.
- The actual score obtained by pre-change survey and post-change survey. The difference in score between the two surveys was also computed. This allowed for identification of major changes between environment 1 and environment 2.
- Standard deviation for both pre-change survey and post-change survey. The standard deviation was computed in order to identify whether a specific survey question was answered similarly by the participants or whether there were large variations.

The survey results can be found in section 5.2.

4.1.3. Stakeholder interviews

The conducted stakeholder interviews resulted in a medium quantity of raw voice data (25 minutes of voice recording). In order to further work with the data, a detailed log file was created for each conducted stakeholder interview. The log files were structured in the sequence of the standard list of questions asked. For each log file, the following data has been recorded:

- Identification of the log. This unique identifier referred to a particular stakeholder interview response for the purpose of this report.
- Question: The question asked at the stakeholder interview. There were 11 prepared questions.
- Answer: The transcribed response given to the question by the stakeholder. This is a detailed transcript where no information has been omitted.

The fact that the detailed responses have been recorded differed to the data coding approach of the user observation where only usability related incidents have been logged. This difference in approach is due to two reasons.

Firstly, the verbal stakeholder responses gathered during the interviews were all relevant to the handover process or the perceived usability of the handover system. In contrast, a large amount of voice data gathered during the video observations related to patients' medical conditions.

Secondly, the combined length of the voice files was significantly smaller than the combined duration of the video files gathered during the user observation. This was due to the fact that the interviews had to be kept at a short duration and that the number of stakeholder interviews was smaller than the number of user observations (see 3.2, constraint 1).

A summary of the findings from the stakeholder interviews can be found in section 5.3. The log files from the stakeholder interviews can be found in Appendix B.

4.1.4. Heuristic evaluation

The two heuristic evaluations resulted in a number of handwritten logs that were noted down during the execution of the two specified tasks. The logs from both heuristic evaluations were added to a single log file. The fact that only one log file was created was due to the limited amount of changes made to the handover system by the CHIP project (see subsection 3.1.3). This had the effect that the majority of the logs applied to both the initial and the updated handover system. For each log, the following data was recorded:

- Identification of the log. This unique identifier allowed for reference to a particular log taken during the heuristic evaluation for the purpose of this report.
- Usability aspect: Grouping of the logs by the ten usability aspects listed in section 2.4. These usability aspects formed a major input into the heuristic evaluation.
- Observation / Comment: Detailed description of the observation made.
- Impact (perception): The author's perception about the impact of the recorded observation on the user. This can either be positive or negative.
- Handover environment in which the observation was made. These are the initial handover environment (E1), the updated handover environment (E2) or both environments.

A summary of the findings from the heuristic evaluations can be found in section 5.4. The log file from the heuristic evaluations can be found in Appendix C.

4.2. Data editing

In the second step of data analysis, the coded data was edited. This further conceptualisation allowed for better comparing and contrasting of the data. This in turn assisted in the process of coming up with conclusions. This approach aligned well with the one suggested by Kushniruk, Patel and Cimino (1997, p. 221) and utilised a list of patterns that have been labelled as usability events for the purpose of this thesis (see subsection 2.3.2 for the definition of usability events). Therefore, all the gathered coded data from the user observation, stakeholder interviews and heuristic evaluation was entered into the list of usability events that formed the main input for the data interpretation (see Figure 3.7, L1 & L2). For each logged event, the following data was captured:

- Identification of the usability event: This unique identifier allowed for forward traceability to the usability design requirements and also provided a reference for the purpose of this thesis.
- Environment: Handover environment in which the usability event was found. These are the initial handover environment (E1), the updated handover environment (E2) or both environments.
- Usability event: Detailed description of the observed usability event. As per the definition given in subsection 2.3.2, a usability event is "an occurrence or feature that impacts the usability of an artefact in positive or negative sense."
- Assessment – Impact (perception): The author's perception of the impact the recorded usability event has on usability. This can either be positive, negative or neutral. It is important to note that, when conducting the assessment, the use of the handover system as primary working surface was assumed (See assumption 1 in section 3.2). Hence, an event that occurred outside the handover system was assessed as negative when it was understood that this happened due to the handover systems inability to support this event in an effective, efficient and/or satisfactory way.
- Assessment – Area: the area of handover to which the usability event can be linked to. The areas align with the three areas of improvement by the CHIP project, i.e. ***Environment***, ***Process*** and ***System***. Two other areas were added:

Information for events that are related to the availability or lack of patient information and ***usability method*** that is used for events linked to the applied usability evaluation method and hence assisted in answering the secondary research question.

- Assessment – Usability aspect (only used where area was ***System***): The usability aspect (as defined in section 2.4) to which the recorded usability event could be linked to.
- Method(s) of discovery: usability evaluation method(s) which highlighted a particular usability event.
- Source (first occurrence): Where a particular usability event has been found for a first time. These are grouped by ***Environment***.
- Number of occurrences: Number (count) and identification for each log linked to a particular usability event. Grouped by ***Environment*** and usability evaluation method.

Note that, due to the quantitative nature of the data, the results from the survey could not be included in the list of usability events. However, they still could be used in order to gain a high level understanding of the current and updated handover environment, process and system, as seen by its users (triangulation of methods).

The list of usability events can be found in Appendix D (columns Identification, Environment, Usability event, Assessment & Method(s) of discovery).

Chapter 5. Findings

This chapter of the report summarises the findings made through the application of the four chosen usability evaluation methods as described in section 3.4. Each section lists a summary of the findings for one particular usability evaluation method. It also provides links to the respective sections of the appendix where the detailed results can be found.

5.1. User observation

The 22 user observations resulted into the following amount of data:

- Two pilot user observation in the initial handover environment of which one was recorded on video and both were attended in person for note taking. These observations led to 44 logs.
- Ten formal user observations in the initial handover environment. All handovers were recorded on video and three events have been attended in person. These observations led to 192 minutes of video recording and 261 logs.
- Ten formal user observations in the updated handover environment. All handovers were recorded on video and 3 events were attended in person. These observations led to 217 minutes of video recording and 240 logs.

The log files for each user observations can be found in Appendix A.

The logs have subsequently been edited and added to the list of usability events. A summary of the findings is listed in Table 5.1. The table shows the number of usability events found though user observation, grouped by area and impact. Also, in order to highlight the effect of triangulation, the table depicts the number of overlapping usability events that have also been identified by the stakeholder interview and heuristic evaluation. Finally, the table also shows how the gathered user observation logs have been assigned to the usability events. Note that the total number differs from the number given above. This is due to the fact that some administrative logs could not been assigned to a usability event while other logs could be assigned to more than one usability event.

Table 5.1

Summary of the findings from the user observations

Usability events					User observation logs	
Area	Impact	Number	Overlap with other usability evaluation methods		Environment	
			Stake-holder interview	Heuristic evaluation	1	2
Environment	Positive	0	0	0	0	0
	Negative	8	4	0	61	21
Process	Positive	6	2	0	11	15
	Negative	34	4	0	145	90
System	Positive	8	0	0	15	44
	Negative	6	2	0	25	17
Information	Positive	0	0	0	0	0
	Negative	20	3	0	48	44
Usability method	Positive	0	n/a	n/a	0	0
	Negative	4	n/a	n/a	9	7
Total		86	15	0	315	240

5.2. Survey

The coded survey results are shown in Table 5.2 below. The results provided a quantitative set of data that helped to gain a high level understanding of the current handover environment, process and system, as seen by its users. The data also helped to understand the relative success of the changes implemented by the CHIP project. Due to the quantitative nature of the data, it was not possible to integrate it into the list of usability events.

Table 5.2

Survey results

Question #		Question	Answer scale		# of replies		Score (rounded to two digit)			Standard Deviation	
Pre-change survey	Post-change survey		From	To	Pre-change survey	Post-change survey	Pre-change survey	Post-change survey	change	Pre-change survey	Post-change survey
1	1	Are Delivery Unit/WA handovers run effectively?	Very Effective	Not Effective	50	53	4.90	2.13	-2.77	2.17	1.46
2	2	Is all essential information on patients handed over?	Always	Never	50	53	3.93	2.24	-1.69	2.06	1.39
3	3	Is patient safety compromised by the current handover process?	Uncompromised	Compromised	50	53	3.87	1.58	-2.29	2.1	1.45
4	4	During handover do you know the other members of the team?	Always	Never	50	53	3.00	1.74	-1.26	2.55	1.79
5	5	Is the current environment where handover takes place, the DU workroom, appropriate?	Inappropriate	Appropriate	50	53	4.54	8.32	3.78	2.87	2.11
6	6	Would changing the environment help improve the handover process?	Helpful	Not Helpful	50	52	3.99	7.49	3.50	2.83	2.76
7	7	Is the current electronic whiteboard useful for handover?	Not Useful	Very Useful	50	53	5.44	7.98	2.54	2.67	1.75
8	8	Is the data on the electronic whiteboard relevant to handover?	Relevant	Not Relevant	50	53	4.14	2.36	-1.78	2.29	2.02
9	9	Do doctors currently handover in a systematic and organised manner?	Organised	Disorganised	50	52	5.34	2.26	-3.08	2.28	1.51
10	10	Would a pro forma be useful for DU/WAU handovers?	Very useful	Not Useful	50	50	3.12	2.01	-1.11	1.82	1.57
11	11	Are outliers appropriately handed over?	Always	Never	50	53	5.77	2.36	-3.41	2.12	1.25
12	12	Who should attend handover?	No scale. 11 roles that could be circled.		n/a	n/a	n/a	n/a	n/a	n/a	n/a
13	n/a	Please add any comments regarding handover if you wish.	No scale. Space for comments.		n/a	n/a	n/a	n/a	n/a	n/a	n/a
n/a	13	Have the modifications to the handover e.g. room, whiteboard and proforma (SHARING) improved the process?	Improved	Not Improved	n/a	46	n/a	1.86	n/a	n/a	1.8

5.3. Stakeholder interviews

The four stakeholder interviews resulted in 25 minutes of voice recording and 43 individual response logs. The log files from the stakeholder interviews can be found in Appendix B.

The logs have subsequently been edited and added to the list of usability events. A summary of the findings is presented in below Table 5.3. The table shows the number of usability events found through the stakeholder interviews, split by area and impact. Also, the table presents the number of overlapping usability events that have also been identified by the user observation and heuristic evaluation, which highlights the effect of triangulation.

Table 5.3

Summary of the findings from the stakeholder interviews

Usability events				
Area	Impact	Number	Overlap with other usability evaluation methods	
			User observation	Heuristic evaluation
Environment	Positive	0	0	0
	Negative	4	4	0
Process	Positive	4	2	0
	Negative	5	4	0
System	Positive	1	0	0
	Negative	14	2	2
Information	Positive	0	0	0
	Negative	2	2	0
Total		30	14	2

5.4. Heuristic evaluation

The two heuristic evaluations resulted in a log file that contains 27 usability events. The log file from the heuristic evaluations can be found in Appendix C.

Table 5.4 shows a summary of usability events found through the application of the heuristic evaluation. The table shows the number of usability events grouped by usability aspect and impact. Also, the table depicts the number of overlapping usability events that have also been found by the user observation and stakeholder interviews. This also highlights the effect of triangulation. Note that due to the nature of heuristic evaluation, all the found usability events are in the area labelled as ***System***.

Table 5.4

Summary of the findings from the heuristic evaluation

Usability events				
Usability aspect	Impact	Number	Overlap with other usability evaluation methods	
			User observation	Stakeholder interview
Visibility and system status	Positive	4	0	0
	Negative	2	0	0
Match between system and real world	Positive	1	0	0
	Negative	2	0	1
	Neutral	1	0	0
User control and freedom	Positive	0	0	0
	Negative	1	0	1
Consistency and standards	Positive	0	0	0
	Negative	2	0	0
Error prevention	Positive	1	0	0
	Negative	2	0	0
Recognition rather than recall	Positive	1	0	0
	Negative	0	0	0
Flexibility and efficiency of use	Positive	4	0	0
	Negative	1	0	0
Aesthetic and minimalist design	Positive	1	0	0
	Negative	1	0	0
Help users recognise, diagnose and recover from errors	Positive	0	0	0
	Negative	1	0	0
Help and documentation	Positive	0	0	0
	Negative	2	0	0
Total		26	0	2

Chapter 6. Conclusion

This chapter of the thesis outlines the key conclusions drawn from this research project. It has been divided into five sections. Section 6.1 revisits the assumptions and constrains that were formulated for this project and how they impact the conclusions in regards to generaliseability. This is followed by two sections that address the primary research question “What are the usability design requirements for a clinical handover system?”. Section 6.2 presents some key design recommendations, while section 6.3 presents the actual usability design requirements. Section 6.4 then presents an example of how the provided usability design requirements can be implemented in a practical context. Finally, section 6.5 presents the conclusion made in regards to the applied usability evaluation methods and framework.

The chapter of the thesis frequently refers to result details which can be found in the appendices. The following abbreviations have been used in the chapter:

- UE: Reference to a usability event. The complete list of usability events is shown in Appendix D;
- UO: Reference to a log item from the user observations. The log files are shown in Appendix A;
- SI: Reference to a log item from the stakeholder interviews. The log files are shown in Appendix B;
- HE: Reference to a log item from the heuristic evaluations. The log files are shown in Appendix C.

6.1. Generaliseability

The conclusions need to be read in understanding of the assumptions and constraints that applied for this project.

6.1.1. Usability design requirements

The generated usability design requirements have been specifically written for a handover system that is used in the area of heath care. Nevertheless, some of the requirements are formulated in a more generalised way and can therefore be applied for other systems in the area of health care as well. However, due to the discussed peculiarities of information technology in heath care settings (see section 2.2), it is difficult to translate the requirements into another field of information technology (e.g. finance).

Therefore, the conclusions made in regard to usability design requirements are of most value to information technology practitioners who work in heath care.

6.1.2. Framework and usability evaluation methods

Three of the constraints outlined in section 3.2 significantly impacted the choice of framework and methods as well as how the selected methods have been applied. Firstly, constraint 3 meant that this project had to align to the schedule of the CHIP project. This largely influenced the research framework outlined in Figure 3.7. Secondly, constraint 1 meant that there was very limited access to real system users. This greatly influenced the selection of methods and the decision for this project to use a few methods rather than just one (i.e. triangulation of methods). Lastly, the author’s limited medical domain knowledge (constraint 4) had a further influence on the application of methods, e.g. the chosen observer role during user observation.

As a result, the conclusions made about the framework and the chosen usability evaluation methods are best to be used by usability experts who are tasked with an usability assessment in an unfamiliar domain, have limited access to system users and no influence on the system development process.

In regards to the area of application, it is believed that the conclusions made are valid outside health care as well. Hence, the application of the framework and usability evaluation methods presents a very common real world scenario and could be of value to a wide range of IT practitioners.

6.2. Usability design recommendations

This section outlines some of the key findings of this thesis and comes up with associated recommendations. These recommendations have been considered during the creation of the actual usability design requirements.

6.2.1. Usability-centric system evolution

This project has shown that usability can only be achieved if the evolution of the handover system addresses users’ specific needs.

Recommendation

This study proposes that Information Technology evolves together with people and work practice. This can be achieved by systems that have frequent small releases that are aligned with process changes and educational initiatives. Further, customisation can help to achieve this goal, by allowing minor system changes that are not dependent on a software release.

The process of evolution that takes place in the case of a handover system could be presented as shown in Figure 6.1.

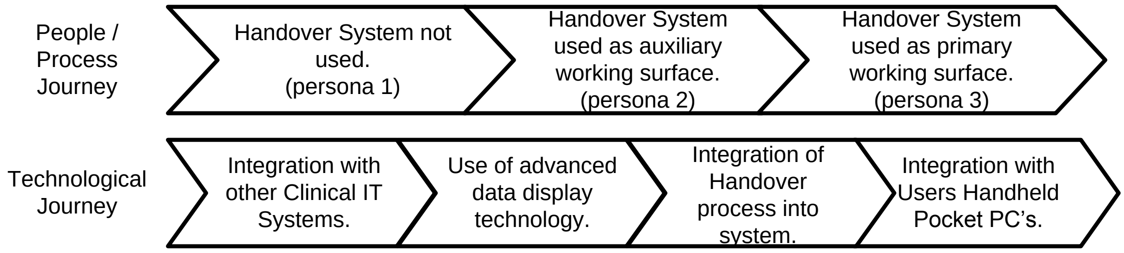

Figure 6.1. **Evolution path journey**

This conclusion is also in line with the findings of Berg (1999) who argues that "[in health care] systems have to be developed step by step, so that the changes in technology and work practice can evolve together".

Potential Real World Example

In the case of Auckland City Hospital, the user observation provided evidence that the handover system is currently being used as an auxiliary working surface by a majority of its users (persona 2). This is evident from the high number of logs for usability events UE076 and UE077, which are both indicators of persona 2. Technologically, the current handover system provides a reasonable match to persona 2, allowing users to access basic patient information (such as name and NHI number) and display it to their colleagues. However, it does not address the handover-related issues discussed in subsection 2.1.2, namely the loss of information. This is due to the fact that the current handover system does not store all the information that has been handed over. Also, the introduced handover process (see subsection 3.1.3) is not reflected in the system.

As such, the following next steps could be taken on the technological journey:

- Voice recording of the handover;

- Implementation of the handover process into the handover system.

Note that the voice recording could be an intermediate step on the technological journey only and might be turned off once all the data has been captured in writing within the handover system (e.g. through the use of pocket PCs). Hence, the handover system needs to provide flexibility that allows for deactivation of functions.

6.2.2. Nature of usability design requirements

At the beginning of this project, the author's hypothesis was that the resulting usability requirements would mainly consist of very specific suggestions in regards to layout and design of the handover system's user interface. For instance, this could have been a requirement that mandated that the most important item of information needs to be placed on the top left hand corner of the user interface as research indicates that users initially focus on that part of the screen (Garlitz, 2002). This hypothesis was further strengthened by the author's work experience where usability requirements often consisted of only this kind of design recommendations. The findings of this study refuted this hypothesis and showed that the scope of usability requirements is far wider. This is especially the case when considering the usability definition given in subsection 2.3.1 which mandates that users' specified goals must be considered when assessing usability.

In conclusion, the thesis showed that usability requirements can be divided into the following two distinctive groups:

- Pure usability requirements (explicit usability requirements): These are detailed and specific requirements that solely address one or multiple usability aspects and do not have any other functional or non-functional purpose;
- Requirements that encompass usability among other aspects (implicit usability requirements): These are requirements that address a functional or non-functional aspect and have not primarily been written with usability in mind. However, the implementation of these requirements does affect usability in one way or another. For example, this could be a non-functional requirement in regards to system response time where a very slow response might negatively impact the user's efficiency and satisfaction, which are two out of three main driving factors for usability.

While the hypothesis only presumed the derivation of pure usability requirements, the application of the four usability evaluation methods showed that there are many functional and non-functional requirements that encompass usability and that their importance outweighs that of the pure usability requirements.

Recommendation

Hence, a further recommendation of this thesis is that all requirements for a handover system should be assessed in regards to their impact on usability. This would allow the developers to assess whether any functional change has, as a side effect, an impact on the system's usability.

6.2.3. Relationship between information availability and usability

The application of the usability evaluation methods has clearly shown that the availability of information is a key aspect of usability. This has been highlighted by the 20 negative usability events related to this issue that have been identified by this research (see Appendix D).

Recommendation

This study proposes to treat the availability of information as an area of usability in its own right. This is in acknowledgement of the important role that information accessibility and availability play in order to achieve the key usability aspects of effectiveness, efficiency and satisfaction (see subsection 2.3.1).

6.3. Usability design requirements

This section identifies and discusses the usability design requirements derived in the course of this study, including the way they have been derived and verified. Each requirement is related to a broad usability principle which aims to ensure that a clinical handover system aligns with the key usability aspects of effectiveness, efficiency and satisfaction (see subsection 2.3.1). The usability design requirements further consider the users' goals and the context of use.

6.3.1. Requirement 1: Customisation

Requirement specification

Administrators and users of handover systems must be able to customise the amount of data recorded in the handover system and displayed on its screen.

Requirement elicitation and analysis

The stakeholder interviews and user observations have shown that there are different needs in regards to what information should be recorded and/or displayed in the handover system. A first discrepancy has been observed in relation to the prospective user's role. The stakeholder interviews showed that midwifes tend to be satisfied with the amount and structure of the information recorded and displayed (see Appendix B, SI 2.4) while doctors (e.g. registrars) have some specific suggestions as to which information needs to be added (see Appendix B, SI 1.2.4, SI 2.4, SI 3.4). Secondly, the display requirements for the DU and WAU spreadsheets seem to be slightly different. This has been highlighted by stakeholder interview comments such as SI 3.4 (see Appendix B) where the user stated that "for WAU, the most important box is the 'referral' one". Thirdly, the user observation provided evidence that the three user personas outlined in Assumption 1 are indeed present and that they have different needs in regards to the amount of information displayed (e.g., persona 2 only requires basic information such as room number as seen in Appendix A, UO 09/25:36 or 15/12:15).

Requirement verification

The requirement for a high level of customisation is also supported by relevant literature, for example Berg's argument against the implementation of rigid IT systems in health care setting (Berg, 1999).

6.3.2. Requirement 2: Information display

Requirement specification

The handover system must provide display capabilities that enable users to present and communicate information to a large audience.

Requirement elicitation and analysis

The user observations during both evaluations have highlighted various issues about the display of patient information. While the CHIP project addressed the hardware part of these issues through the use of a large wall-mounted monitor, the software part remained unsolved as the changes applied to the electronic whiteboard application were only minor (see subsection 3.1.3). The issues identified in regards to information display were as follows:

- Size of displayed information. The number of observation logs related to this usability event (UE051) decreased during the second evaluation from 20 down to four instances. This is mainly attributed to the larger screen. However, some information on the new screen is still not readable to all participants due to small, non expandable text size (fro example, see UO 14/04:29 or 18/13:29 in Appendix A). The stakeholder interviews (e.g. Appendix B, SI 3.4) and heuristic evaluation (e.g. Appendix C, HE-01) both highlighted that information is invisible due to the fact that it exceeds the size of the grid cell or the screen of the handover system.
- Selection of information. An issue logged in many instances (e.g. Appendix A, UO 14/04:30) is that the participants at the handover are unaware of which piece of information is currently mentioned.

Requirement verification

Li (2011) points to the large font size and good visibility as the key success factors when arguing for the use of a non-electronic whiteboard. This highlights the fact that an electronic solution must incorporate these aspects in order to maintain good usability.

6.3.3. Requirement 3: Information accessibility

Requirement specification

All information required at the handover needs to be accessible through the handover system.

Requirement elicitation and analysis

The stakeholder interviews and user observations have revealed that not all required information is available in the handover system. The following information was not available in the system:

- Detailed medical information about patients (see UE057)
- Administrative information about patients, e.g. admission date (see e.g. Appendix A, UO 11/25:53)
- Administrative information about the ward, e.g. shift, staff and their contacts (see e.g. Appendix A, UO 10/00:31)

6.3.4. Requirement 4: Information availability

Requirement specification

The handover system must be built in a way that ensures that the information is accessible at all times (i.e. 24x7) regardless of planned or unplanned system downtime.

Requirement elicitation and analysis

The stakeholder interviews and user observations have revealed that instant availability of the required information is of crucial importance for clinical handover. Further, the user observations have shown that the current handover system does not fulfil this requirement. This has been highlighted during the 6th user observation (see Appendix A) where the handover system (electronic whiteboard application) was unavailable due to technical problems. Although there was no clear indication that the handover was impaired as a result, this is likely due to the fact that the handover system at Auckland Hospital is currently used as an auxiliary working surface by a large number of users that can be described by persona 2 (see assumption in section 3.2). If more users switch to persona 3 (handover system as primary working surface), then availability of data becomes more important.

6.3.5. Requirement 5: Process incorporation

Requirement specification

The handover system must be flexible in order to allow the organisation to incorporate and protocol their handover process into the system.

Requirement elicitation and analysis

The user observations in environment 1 highlighted that there was no formal handover process. In environment 2, after a handover process has been implemented by the CHIP project, this process was not followed or only followed loosely. Examples of the process not being followed are when participants arrive late for the handover (UE016), when some handover takes place outside of the official handover (UE011) or when the handover is split into multiple discussions (UE028).

6.3.6. Requirement 6: Traceability and auditability

Requirement specification

The handover system must allow for traceability of the information back to its source (e.g. author).

Requirement elicitation and analysis

The usability events related to information have revealed that it is often difficult to capture all the required patient's information and that, in some cases, another person needs to be consulted in order to clarify and/or elaborate on the provided patient's information (see UE038 & UE039). Hence, it is paramount that the author of the information is known so that he/she can be contacted if needed.

6.4. Practical implementation of usability design requirements

Below Figure 6.2 shows how the usability design requirements listed in section 6.3 could be implemented in a practical context. The example applies for a handover system that has been customised/configured for the purpose of the clinical handover in the Women's Health Department at Auckland City Hospital.

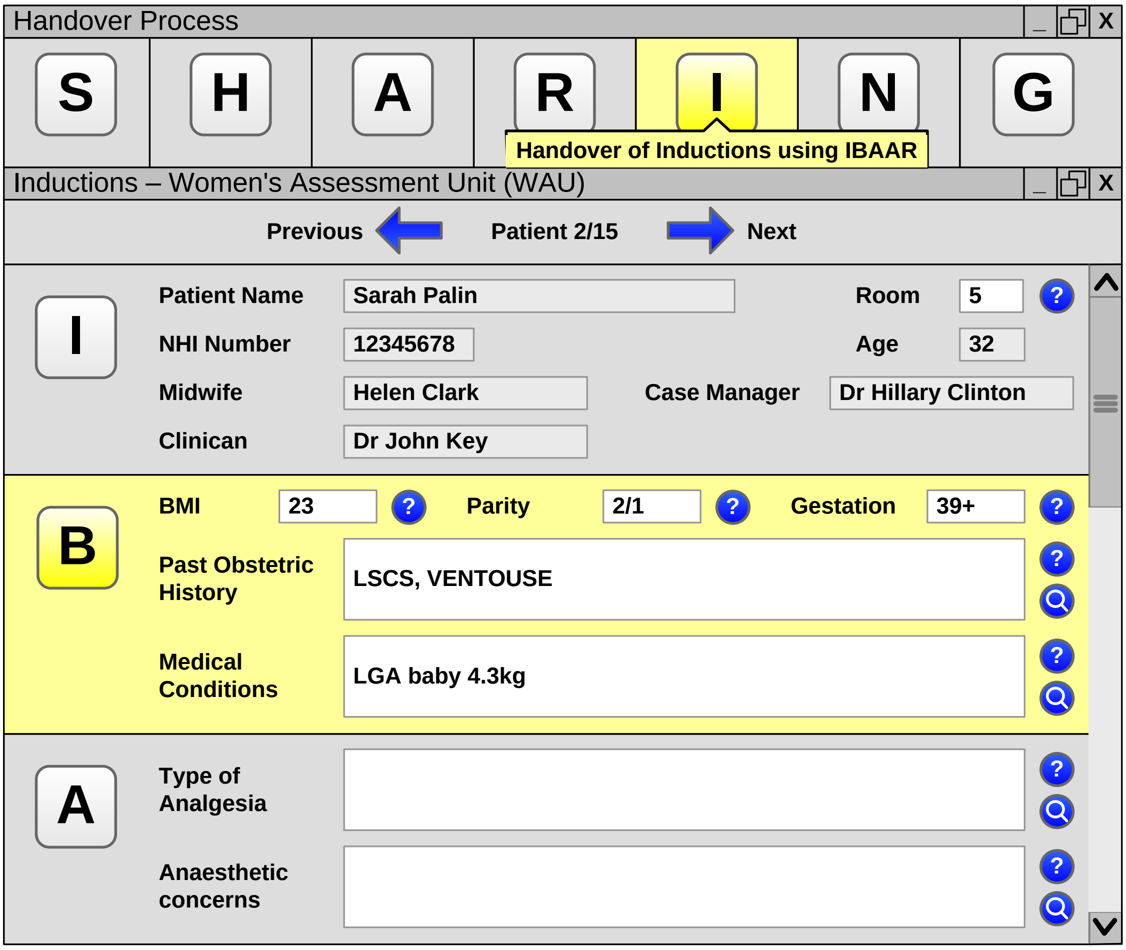

Figure 6.2. **Proposed implementation of usability design requirements**

The discussed usability design requirements have been implemented as discussed below.

6.4.1. Requirement 1: Customisation

The administrator configuration for the example presented in Figure 6.2 foresees the following configuration possibilities:

- manually select required data from all available entities in the central database;
- freely arrange and group data entities on the display of the handover system;
- re-label data entities in the handover system;
- define amount of information to be displayed on screen ('box size');
- limited selection as to whether a data entity is read only (grey background) or read/write (white background);

- Manually define new data entities that can be added to the central database without the need of a new software release and/or database extension.

6.4.2. Requirement 2: Information display

This requirement has been addressed through various changes as explained below:

- Displaying only one patient's information per screen reduces the information overload onto the users, gives more room to present the information and focuses the handover participants' attention to the currently discussed patient.
- Highlighting particular information (in accordance with the IBAAAR proforma) further focuses the handover participants' attention to the patient's information that is discussed at the time.
- Implementation of a 'magnifying glass' button. Upon rolling the mouse over the button, the information of a particular data field is enlarged and shown in full (where information exceeded predefined window size). This allows handover participants to focus on information that is frequently discussed in detail.

6.4.3. Requirement 5: Information accessibility

The architecture for the example presented in Figure 6.2 does not include a separate handover system database. Instead, the system makes use of a central CMS database with which it is integrated (amongst all other systems that are used at the hospital).

6.4.4. Requirement 4: Information availability

The architecture for the example presented in Figure 6.2 presumes a highly available system that consists either of a 'hot/standby' or two concurrently working handover systems with constant data synchronisation. Note that such requirements also need to extend to systems with which the handover system is integrated with, namely the CMS database.

6.4.5. Requirement 5: Process incorporation

This requirement is important as it ensures that the handover system becomes the primary working surface. The requirement has been implemented as explained below:

- Configurable window where the overall handover process can be displayed (in case of CHIP, this is the SHARED proforma). This includes selectable process steps that can be highlighted.
- Separate configurable windows for each step of the overall handover process. Note that the given example only shows the window for the patient handover. However, there could also be a window for other steps of the process. For example, a list of required attendees could be presented in the 'Staffing' part. The handover lead would then need to select an attendance status for each person.
- The grouping of the information in the shown window has been aligned with the 'IBAAAR' proforma that is used for the handover of individual patients.

6.4.6. Requirement 6: Traceability and auditability

This requirement has been implemented by the implementation of a 'question mark' button that has been assigned to each read/write entities. Upon rolling the mouse over the button the following information will be displayed:

- Author of the currently displayed information;
- Previously entered information, including its author;
- Optional: Useful information such as explanation of abbreviations that are frequently used for this data entity.

The use of the 'question mark' button allows the hiding of information that is not frequently used. This enhances the visibility without compromising data completeness, traceability and auditability.

6.5. Usability evaluation methods

Table 6.1 shows a comparison of key conclusions made after the application of the four selected usability evaluation methods. The following four subsections of this chapter elaborate on the conclusions made for each method.

Table 6.1

Comparison of usability evaluation methods (post research)

UEM	Type	Output Data type	Output Data Area	Output Data overlap	Triangulation (examples)	Purpose of UEM	Nature of UE generated from method	Type of UR generated from method	Cost
UO	User Based	Mainly qualitative	Mainly Environment & Process	SI		1) Generation of UR	Mainly negative	Mainly implicit UR	High
SU	User Based	Qualitative	Mainly Environment & Process	none	1) Verification of UR 2) Interpret. of UO	1) Verification of UE 2) Verification of UR	none	none	Med.
SI	User Based	Qualitative	Environment, Process & System	UO & HE	1) Verification of UR 2) Interpret. of UO	1) Generation of UR 2) Verification of UR	Mainly negative	Mainly implicit UR	Med.
HE	Expert Based	Qualitative	System	SI		1) Generation of UR	Positive and negative, relatively equally split.	Mainly explicit UR	Low

Table Key:
- HE: Heuristic Evaluation
- SI: Stakeholder Interview
- SU: Survey
- UE: Usability Events
- UEM: Usability Evaluation Method
- UR: Usability Requirements
- UO: User Observation

6.5.1. User observation

As mentioned in the explanation of the methodology in subsection 3.4.1, the user observations have been done in a non-intrusive way where the observer took the role of an onlooker. Given the project-related constraints, this method could be applied extensively as the cost of capturing video files was comparatively low and did not require much stakeholder involvement (see constraint 1). However, it has been found that the subsequent analysis of the resulting large amount of qualitative output data was a time-consuming task, contributing to a high overall cost for the application of this method.

Further, the user observations led to the discovery of a large number of usability events in the area of ***environment*** and ***process*** (48 events) with a much smaller number of events found in regards to the handover system itself (15 events). This has been attributed to the fact that the deficits in the environment and process led to a decreased system use where users typically only used the handover system as an auxiliary working surface (persona 2) or did not use it at all (persona 1). Further, it is believed that some of the system-related usability events could have been missed due to the video camera being focused on the participants and either did not capture the screen of the handover system (environment 1) or captured it only partially (environment 2) (see Figure 3.3). Hence, this project concludes with the recommendation of making use of screen capturing or input capturing software.

Given the nature of captured usability events, the usability requirements that have been elicited from the user observations are mainly of implicit nature, i.e. they are functional requirements in regards to environment and process that encompassed usability amongst other aspects.

The analysis data captured by video during the user observation has led to the following two conclusions:

- Hawthorne effect: Out of 545 log items taken during the user observation, only 3 (0.55%) identified a participant being visibly distracted by the video camera and/or any other device related to the handover observation. In addition, four logs (0.73%) were about a handover participant mentioning the video camera, which is an indication of a possible distraction. This relatively low level of log items in regards to the user distraction gives evidence that the handover participants were not overly distracted and might not have behaved significantly differently when compared to non-observed handover participants.
- Angle of video camera: Neither in environment 1 nor in environment 2 were all handover participants visible in the video. This resulted in a possible loss of visible cues. However, most of the participants that had an active role during the handover were seated in a place which was in the video scope. Hence, there were only two observations logs (0.37%) where active handover participants were not visible in the video. In order to overcome this problem, it is recommended that the observer also attends in person.

Finally, in regards to the researcher’s medical domain knowledge and his observer’s role during the user observation, this project concludes that in-depth knowledge is not necessary. In fact, extensive medical domain knowledge could lead to biased log-taking. This could manifest itself by omitting logs about users asking for information they "should not be asking for in the first instance". However, such logs could highlight the existence of different working styles or the need for more professional training. Hence, the unbiased log-taking of the onlooker observer, who possesses none or little domain knowledge, could be of enormous value.

6.5.2. Survey

Given the application of survey within the constraints of this project (see subsection 3.4.2) this method was not able to generate usability events or usability design requirements. However, the survey results still provided valuable input as they allowed to verify, at a high level, whether or not the identified usability events were 'felt' by the actual users at the handover. The results also allowed to measure the relative success of the changes applied in order to modify the initial handover system (environment 1) into the updated system (environment 2). They also helped to assess whether or not the usability-centric system evolution (see subsection 6.2.1) was going into the right direction or it needed to be adjusted. Last but not least, although the survey could not identify particular usability events, it could prove the existence of such, namely the existence of positive usability aspects. Hence, it provided a counter balance to the user observation and stakeholder interviews which mostly focused on negative usability events.

In summary, the survey outcome was an important contributor to the concept of triangulation of methods and this project concludes with the recommendation to make use of survey data, even in case where it cannot make direct contribution to the elicitation of usability design requirements.

6.5.3. Stakeholder interviews

In contrast to other applications in the usability domain, the stakeholder interviews have not been directly linked to the user observation (e.g. walk with the user through the video recording). Instead, they have been run as a separate method of inquiry. This was due to the constraint of having limited access to users (see constraint 1 in section 3.2), since it was not possible to book them for time-consuming follow-up interviews. Due to the same reason, the method of stakeholder interviews could not be applied extensively.

Nevertheless, the interviews proved to be of crucial importance to the process of generating usability design requirements.

The first advantage of this method was that the output data (i.e. the generated usability events) largely overlapped with the ones found during the user observations and heuristic evaluation. This was highlighted by the fact that roughly half of the usability events noted during the interviews could be confirmed by the user observations (14 out of 30 usability events). Therefore, the stakeholder interviews helped to verify and inform the findings of the user observations.

Another noted advantage was that the stakeholder interviews (alongside the user observations) helped to understand the context of use, which was important for the evaluation of the second heuristic, namely match between system and real world (see Table 2.3). Without this knowledge, it would have been difficult to apply this particular heuristic, leading to the oversight of some important usability indications recorded during the heuristic evaluation.

Due to these advantages, the stakeholder interviews allowed for a practical application of the concept of method triangulation and it is recommended to apply this method whenever possible, even if there is only limited access to users.

6.5.4. Heuristic evaluation

The expert-based heuristic evaluation complemented the three other, user-based, usability evaluation methods. The application of this method led to several conclusions.

Firstly, the usability events resulting from the heuristic evaluation were almost equally split between positive events (44.44%) and negative events (51.85%) (Note that the remaining 3.7% of events were classified as ‘neutral’). This is in contrast to the user observation which largely resulted in the recording of negative usability events (83.72%). Hence, the expert-based usability evaluation method of heuristic evaluation is a good means of addressing the reported issue of over-emphasising usability issues and ignoring usability successes (see subsection 2.6.6).

Secondly, the heuristic evaluation proved to be a very cost-effective usability evaluation method. The time required to prepare and execute the two evaluations and to code, edit and analyse the results did not take more than ten hours. This is in stark contrast to the other methods, in particular the user observation, which took significantly longer time (more than 100 hours). However, it needs to be mentioned that this estimated time does not include the time spent for building the required subject-specific knowledge (e.g. the handover process), which largely took place during the stakeholder interviews and user observation.

Thirdly, the heuristic evaluation was the method that led to the highest number of system-related usability events (27), which are the main contributors to the derived usability design requirements.

In summary, this project concludes with the suggestion to apply heuristic evaluation if other – user-based – methods are deployed in conjunction. This allows to leverage the subject specific knowledge built by the evaluator and to verify the findings of the different methods against each other.

Chapter 7. Future Work

This study contributes to the field of usability research by providing a scientifically informed usability assessment of clinical handover within a real-world environment. This final chapter of the report suggests further research directions in this area. Since usability is a very broad and evolving field of science, the suggested future work is limited to two specific directions. Firstly, section 7.2 looks at the potential of continuation studies, which could aim at the implementation and verification of the derived usability design requirements. Secondly, suggestions are made in regards to studies that utilise a similar framework and usability evaluation methods (section 7.3.). The suggestions partially aim to address some of the limitations faced during this study. Therefore, section 7.1 briefly re-visits these limitations. Finally, the report concludes with a closing statement in section 7.4.

7.1. Limitations

The real-world nature of this study was paired with a number of limitations that influenced the chosen research framework and methods. One particular limitation, due to the interlock with the CHIP project (see constraint 3 in section 3.2), was that the findings of this research could not be implemented in the handover system used by Auckland City Hospital. Further, the restricted access to system users (see constraint 1 in section 3.2) meant that not all findings in regards to usability evaluation methods could be verified with users to the desired extend.

7.2. Usability design requirements

In regards to the usability design requirements and recommendations that are outlined in section 6.3 and 6.2 respectively, it would be interesting to see them implemented in a future handover system at Auckland City Hospital. In particular, a practical implementation of requirement 2 (information display) and requirement 5 (process incorporation) is desirable as these changes would target areas with the greatest need of improvement. The implementation could be guided by the practical example given in section 6.4 and would allow Auckland City Hospital to take the next step in the technological journey (see Figure 6.1). A subsequent usability evaluation, applying the same framework and methods, could then reveal as to whether or not the usability of the system and the success of the handover process in general improved. The difference could be assessed by considering the ratio of positive usability events versus negative usability events.

Further, the usability design requirements and recommendations derived from this research could be also implemented elsewhere, for example in other hospital wards. This could give some new and interesting insights into their validity and allow researchers to further elaborate and/or refine the requirements.

Last but not least, it would be interesting to establish whether the derived requirements also apply for handover systems that are used in a different context, for example for clinical handovers between different hospitals.

7.3. Usability evaluation methods

The application of the chosen framework and usability evaluation methods could be re-evaluated by other practitioners and researchers. Given the real world suitability of the framework, it is believed that there are countless opportunities to do so. It would then be interesting to establish how differences in method application affect the effectiveness of the method. For instance, would a user observation that also utilises screen capturing software lead to a higher yield of detailed and specific usability requirements derived by that method? Or would a heuristic evaluation that has been informed to a lesser extent by other methods (e.g. lack of triangulation) lead to the identification of fewer usability events? Also, how would the results differ if the constraints that applied for this research were not present? The findings of such studies could then be reported in a manner similar to their presentation in this study (see Table 6.1), allowing researchers to better compare and contrast the different usability evaluation methods. It is believed that such comparisons would be of enormous value for researchers and usability practitioners who face the difficult decision of choosing a set of usability evaluation methods and decide upon their practical application.

Further, it would be useful to see the framework and methods applied in this study to be implemented in other fields of information technology. For example, what would be the impact on the requirements derived from user observation if the observed activity requires a lesser amount of subject matter knowledge than a medical handover? These findings could verify whether the stated conclusion of high generaliseability is correct.

7.4. Closing statement

Through this study I have increased my understanding of usability and how usability can be assessed accurately. Reflecting on my pre-study anticipation, the results in two particular areas came as a surprise to me.

Firstly, this study unveiled that the variability of way users interact with a system is much greater than anticipated. The four usability evaluations showed that usability issues far exceed what a designer or programmer could possibly imagine. This strengthened my belief that usability testing on mock-up screens or prototypes is an absolute must, not just “nice to have”.

Secondly, I have learned that IT in health care has many more intrinsic characteristics than expected. In order to overcome the many reported issues in this area, IT professionals need to really understand the working patterns and thinking of health care professionals.

Looking ahead, I hope that I can find a professional environment where I can constructively apply the wealth of knowledge gained during my work on this interesting and challenging study.

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Appendix A: Log files from user observation

Table A.1

Log file from 1st user observation

Handover Observation - 11-Mar 2011 / 07:45-08:15 (Observation logs in chronological order)		
#&Time	Type	Observation
01/a	PO	People who stand in the back are not able to read anything on the screen.
01/b	PO	One person is taking notes on paper.
01/c	PO	Printer starts working in the background and produce considerable noise.
01/d	PO	A Doctor from the new shift leans forward since he does not seem to be able to read the screen.
01/e	PO	One Doctor from the new shift arrives late for the handover. He watches the observer and seems to be disrupted by his presence.
01/f	PO	The atmosphere at the handover is fairly relaxed and there is some joking.
01/g	PO	Discussion does not seem to focus on the screen of the current handover system. Sometimes the Doctor from the current shift who leads the handover turns around to the people from the new shift in order to face them.
01/h	PO	Two people from the new shift starting to have a separate discussion in the background.
01/i	PO	No discussion items seem to be added to the handover system. Indication that people are more likely to rely on their memory and/or handwritten notes.
01/j	PO	Detailed discussion about one patient starts. This information does not seem to be available in the system.
01/k	PO	Doctor who arrived late for the handover is again watching the observer and seems to be disrupted by his presence.
01/l	PO	It looks like there is a second run through the list of patients, led by another doctor from the old shift.
01/m	PO	Watch in the background produces some noise.
01/n	PO	Someone not participating in the handover is entering the room and starts working on a pc.
01/o	PO	The Doctor who arrived late for the handover leans forward in an attempt to read some information on the screen.
01/p	PO	The mobile phone of a person attending the handover is ringing.
01/q	PO	Someone enters the room and is having a discussion with the person who does some unrelated work on the pc.
01/r	PO	Printer starts again and produces considerable background noise.

Table A.2

Log file from 2nd user observation

Handover Observation - 23-Mar 2011 / 08:00-08:20 (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
02/00:43	PO/VC	Outgoing consultant is handing over a specific patient which is a complex case.
02/01:13	PO/VC	Trainee Doctor
02/01:40	VO	Charge midwife seems to be occupied by reading another paper as opposed to listening to the handover.
02/01:41	VO	Outgoing registrar of DU seems to be distracted by the camera.
02/02:16	PO/VC	Handover of specific patient by consultant is not structured at all. However, VC regards this as a good handover.
02/a	PO	People leaving because the handover of the patients in the WAU is done there (due to the pc not being available).
02/03:37	PO	Two attendants are taking a paper out of the printer in order to take notes.
02/03:52	PO/VC	Incoming consultant for the WAU arrives late.
02/04:35	PO/VC	Some attendants of the incoming shift take notes on a plain paper. Normally, they would take notes on a printout of the patients sheet from the pc. However, as the system was down, this was not possible at this particular handover.
02/05:20	PO/VC	The charge midwife left as the assist bell went off (there is also an emergency bell).
02/11:29	PO/VC	The outgoing Registrar does not know what is going on in certain rooms of the DU as the software is not available.
02/11:31	VO	The incoming consultant of the WAU is leaving the room in order to find the charge midwife who left earlier.
02/11:38	VO	Filming of the handover becomes the subject of a joke.
02/11:59	VO	Outgoing registrar of DU starts handing over two inductions from the WAU. She is taking a paper out of the pocket for details about those patients.
02/12:19	PO/VC	The incoming consultant of the WAU returns to the room.
02/12:25	VO	Background noise from printer. Registrar from the incoming shift starts reading the printout.
02/13:17	PO/VC	The handover of the outgoing registrar is regarded as well structured.
02/13:36	VO	The charge midwife returns to the room.
02/14:07	PO/VC	The charge midwife hands over patients that did not required attention from the outgoing registrar during her shift. This handover is regarded as low quality. For instance, the charge midwife mentions the baby's estimated weight but none of the other crucial information.
02/14:42	PO/VC	Not enough information has been given for a patient that experience difficulties during the previous shift.
02/15:18	PO/VC	Conflicting information about whether or not a patient has gone to the theatre.
02/15:30	PO/VC	It is not known whether there are available beds for other incoming patients.
02/16:50	VO	Incoming consultant of DU confirms whether people in the background (not visible) are Anaesthesiologists and whether they have updates respectively have all the information they need.
02/17:36	PO/VC	Handover finished for DU. Continues for WAU in other room
02/19:12	PO/VC	Student and incoming consultant decide how the approach the work.
02/20:24	PO/VC	Oncoming consultant introduced herself to the Anaesthesiologists at the end of the handover (as opposed to the beginning).

Table A.3

Log file from 3rd user observation (initial handover environment)

Handover Observation - 12-April 2011 / 08:00-08:18 / File 12 April.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
03/00:30	VO	Discussion as to which patients should be handed over first.
03/00:35	VO	Outgoing DU Registrar is interacting with handover system through the mouse.
03/00:40	VO	Outgoing DU Registrar leans forward and looks at the screen of the handover system. Gesture indicates that she has been reminded of the patients. She stands back and starts handover from memory.
03/00:52	VO	Incoming Registrar leans forward in order to read from the screen of the handover system.
03/02:55	VO	Outgoing DU Registrar mentions all medication given to a patient entirely from memory.
03/03:06	VO	Outgoing DU Registrar mentions a medication given to a patient but says that this information needs to be checked.
03/03:11	VO	Person enters room and starts to work on the computer in the background
03/05:56	VO	Handover splits into two discussions for a short time.
03/06:06	VO	Phone beside handover system rings.
03/06:12	VO	Outgoing WAU Registrar picks up the phone.
03/06:40	VO	Outgoing WAU Registrar (on the phone) looks at the screen of the handover system and passes some information to the caller while the other participants continue the handover.
03/06:59	VO	Outgoing WAU Registrar (on the phone) asks the people attending the handovers as to who could assist the callers query. She hands over the phone to the Charge Midwife.
03/07:56	VO	Outgoing DU Registrar hands over a patient from memory. Gesture indicates that she struggles to recall some information.
03/09:15	VO	Outgoing WAU Registrar starts handing over patients. She looks at the screen of the handover system in order to be reminded of the patients she needs to hand over.
03/09:24	VO	Incoming Registrar leans forward in order to read from the screen of the handover system.
03/09:38	VO	Outgoing WAU Registrar is being asked a question about a patient. She mentions that she hasn't seen another staffs notes as the person has not yet turned up.
03/09:48	VO	Outgoing WAU Registrar starts handing over a new patient. She looks at the screen of the handover system in order to be reminded of the patients. She then starts handing over the patient by looking at her notes.
03/09:58	VO	Incoming Registrar takes handwritten notes.
03/12:25	VO	Outgoing WAU Registrar tries to describe a graph by pointing with her finger.
03/12:42	VO	Outgoing WAU Registrar asks "who else is left", then looks at the screen of the handover system in order to be reminded of outstanding patients.
03/17:15	VO	Outgoing WAU Registrar is being asked a question about a patient. She confirms that she does not know the answer.
03/18:05	VO	Handover ends.

Table A.4

Log file from 4th user observation (initial handover environment)

Handover Observation - 13-April 2011 / 08:00-08:15 / File 13 April.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
04/00:27	VO	First outgoing Registrar is asked a question and confirms that she does not know the answer.
04/00:50	VO	First outgoing Registrar hands over patients by referring to notes on paper.
04/01:12	VO	Bell sounds in the background
04/01:56	VO	First incoming Registrar takes handwritten notes.
04/02:08	VO	Second Incoming Registrar asks a question. First outgoing Registrar confirms that she does not know the answer.
04/02:31	VO	Second Incoming Registrar leans forward and interacts with handover system through the mouse.
04/04:20	VO	First outgoing Registrar confirms that she did not have time to "catch-up with the inductions".
04/04:28	VO	Some confusion as to which room is handed over. Incoming registrars confirm with handover system and first outgoing registrar is turning her paper with the notes.
04/07:09	VO	First incoming Registrar looks at the notes from the second outgoing registrars and then writes on her own notes sheet.
04/08:10	VO	Second incoming Registrar stands up, intends to leave.
04/08:22	VO	Person (not visible) asks a question. First incoming Registrar confirms that she does not know the answer.
04/08:47	VO	Handover seems to continue with other participants.
04/09:35	VO	Third outgoing Registrar hands over patients by referring to notes on paper (shows paper to other participants).
04/09:46	VO	Phone rings in the background.
04/11:09	VO	Mobile Phone of first incoming Registrar rings.
04/11:42	VO	Third outgoing Registrar hands over a patient by pointing at the screen of the handover system.
04/12:25	VO	Mobile Phone of second incoming Registrar rings.
04/14:20	VO	Incoming SMO checks his mobile phone.
04/15:00	VO	SMO leaves handover.
04/15:20	VO	Handover ends.
04/a	VO	The handover system served as an auxiliary working surface. The primary working surfaces were the handwritten notes.
04/b	VO	The handover process was rather unstructured.

Table A.5

Log file from 5th user observation (initial handover environment)

Handover Observation - 14-April 2011 / 08:00-08:12 / File 5 May.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
05/00:14	VO	Printer starts in the background.
05/00:31	VO	First outgoing Registrar mentions that she will first handover the patients who have to go theatre.
05/00:45	VO	First outgoing Registrar leans forward and looks at the screen of the handover system. Gesture indicates that she has been reminded of the patients to handover she then starts handover from memory.
05/01:02	VO	First outgoing Registrar mentions that she does not know the exact time of an event by saying "five o'clock or something like that".
05/02:05	VO	Incoming SMO leans forward in order to read from the screen of the handover system.
05/03:23	VO	Detailed discussion about one patient between first outgoing Registrar and incoming SMO. First outgoing Registrar gives information from memory and incoming SMO is looking at the screen of the handover system while listening. He doesn't take any notes, neither on the handover system nor handwritten.
05/05:16	VO	First outgoing Registrar looks at paper notes in order to get some information about a particular patient.
05/06:44	VO	Incoming SMO takes handwritten notes on a plain piece of paper.
05/09:15	VO	Incoming SMO is pointing at the screen of the handover system and asking a question about a patient.
05/09:54	VO	Mobile phone of incoming SMO rings.
05/10:38	VO	First outgoing Registrar speaks and then stops in order to recall information about the patient being handed over.
05/11:22	VO	Handover ends.
05/11:38	VO	Some patients are being discussed after completion of the handover.

Table A.6

Log file from 6th user observation (initial handover environment)

Handover Observation - 18-April 2011 / 08:00-08:17 / File 18 April.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
06/a	VO	Handover in other Environment (Environment "1a") which is a meeting room without handover system.
06/01:02	VO	First outgoing Registrar indicates that she does not know the detailed information by saying "I think" and "… something".
06/03:20	VO	Incoming participants take handwritten notes.
06/03:22	VO	Bell rings in the background.
06/05:03	VO	First outgoing Registrar indicates that she does not know the detailed information by saying "I am not sure".
06/05:43	VO	First outgoing Registrar hands over patient by reading from note paper (possible printout from handover system).
06/07:17	VO	Mobile phone of first outgoing Registrar rings.
06/07:23	VO	First outgoing Registrar leaves room.
06/08:29	VO	First outgoing Registrar re-enters room.
06/14:15	VO	First outgoing Registrar seems suddenly to remember a patient that has been forgotten.
06/14:25	VO	First outgoing Registrar hands over patient entirely from memory.
06/14:57	VO	First outgoing Registrar does not know who is following patient up.
06/16:50	VO	Handover ends.

Table A.7

Log file from 7th user observation (initial handover environment)

Handover Observation - 19-April 2011 / 08:00-08:09 / File 19 4.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
07/00:00	VO	Video starts, handover is already in progress.
07/00:25	VO	Some discussion in the background.
07/01:09	VO	Charge Midwife leans forward in order to enter some additional information into the system.
07/01:35	VO	Person cannot remember as to why there was an induction. Does neither check his printout nor the screen.
07/01:57	VO	Person cannot remember the weight of a patients previous baby nor her name. Checks the name in another computer.
07/02:20	VO	Person is interrupted by another person and starts an conversation with her.
07/02:50	VO	Pager of Person starts beeping.
07/02:51	VO	Handover switches away from handover system and outside of camera angle.
07/03:08	VO	Person watches screen of handover system while handover happens away from the system.
07/03:13	VO	Handover switches back to the handover system.
07/03:18	VO	Beeping sound in the background for two seconds.
07/03:40	VO	Two people start working at the pc in the background and having an conversation
07/03:56	VO	Beeping sound in the background for two seconds.
07/04:20	VO	Person is reading text message on the phone.
07/05:38	VO	Person is searching for some information on another computer.
07/06:24	VO	Person is reading information from paper as opposed from handover system.
07/07:44	VO	Person is searching for some information on another computer.
07/08:55	VO	Handover ends.

Table A.8

Log file from 8th user observation (initial handover environment)

Handover Observation - 28-April 2011 / 08:00-08:27 / File 28 4.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
08/01:51	VO	Person hands over completely without the help of the handover system or notes.
08/06:41	VO	Person mentions that she did not write some information into the handover system and asks another handover participant to right it down (later).
08/07:02	VO	Person leaves the handover.
08/07:04	VO	Attention turns to the handover system.
08/07:30	VO	Printer starts in the background.
08/07:41	VO	People waiting for the printout.
08/07:50	VO	Person leans forward in order to read screen of handover system.
08/08:32	VO	Person leans forward in order to see information on screen of handover system.
08/09:17	VO	Paper given to other handover participant.
08/09:24	VO	People speaking in the background.
08/10:22	VO	Person looks backward, seems to be distracted.
08/10:25	VO	Someone enters the room and starts working at the copier/printer.
08/10:37	VO	Another person enters the room and starts speaking with the person working at the copier/printer.
08/11:37	VO	Assist bell went off.
08/12:05	VO	Person hands over a patient and seems to read all the information from the screen of the handover system.
08/12:11	VO	Mobile phone rings. One person hands over the phone to another person.
08/12:14	VO	Person leaves the room.
08/13:01	VO	Person doing the handover is called by someone outside of the camera angle.
08/13:30	VO	Person outside angle is giving some information.
08/14:44	VO	Person is searching for some information on another computer.
08/15:27	VO	Person enters room with file and provides another person some information.
08/16:02	VO	Discussion about a patient that does not seem to have a doctor assigned to her.
08/16:38	VO	Handover of inductions. Person hands over the first patient. Reads some information from a paper. Looks like he also reads some information from the screen of the handover system.
08/17:34	VO	Person leans forward in order to see information on screen of handover system.
08/19:48	VO	Person enters room and leans forward in order to see information on screen of handover system.
08/20:43	VO	Person is searching for some information on another computer.
08/22:43	VO	Person hands over a patient by looking at the notes of another participant.
08/23:43	VO	Handover participant is searching for some information on another computer.
08/23:49	VO	Phone rings in the background.
08/25:33	VO	Handover ends.
08/27:03	VO	Some additional handover between two handover participants seems to occur.

Table A.9

Log file from 9th user observation (initial handover environment)

Handover Observation - 29-April 2011 / 08:00-08:36 / File 29 4.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
09/00:30	VO	Person does not seem to know which patients are summarised on Person printout of the handover system.
09/00:43	VO	Person does look up some information, that seems not to be available on Person printout, on own paper.
09/01:02	VO	Someone enters the room and is greeted by Person.
09/01:11	VO	Person switches between printout and screen of handover system. Looks like the information handed over cannot be found.
09/01:14	VO	Printer starts in the background.
09/01:17	VO	Person writes down information about patient who is handed over by Person on printout of handover system.
09/01:27	VO	Person is engaged watching people at the printer as opposed to the handover.
09/02:11	VO	Two people discuss a paper in the background.
09/02:15	VO	Person arrives at the handover.
09/02:45	VO	Person states "I can't remember all the details".
09/03:49	VO	Focus of discussion is not the handover system.
09/04:36	VO	Phone rings in the background.
09/04:44	VO	Person refers to another participants printout of from the handover system in order to determine what other information about a patient needs to be handed over.
09/05:03	VO	Person refers back to a paper with handwritten notes on it.
09/05:14	VO	Person does look for information on printout from handover system but then folds the paper.
09/05:35	VO	Person is searching for some information on another computer.
09/05:57	VO	Person asks whether anyone in the room knows about the "other WAU patients". Two participants immediately look at the papers they have in their hand.
09/06:00	VO	Person asks whether anyone knows about the DU patients. Person refers to someone in the back of the room (person cannot be seen in the video).
09/06:15	VO	Person starts to handover a patient. Reads information from the screen of the handover system.
09/06:28	VO	Person looks at the paper in his hand and ask a person (cannot be seen in the video) "who are these people?".
09/06:37	VO	Focus of discussion shifts to a participants paper.
09/06:52	VO	While looking at the paper of another Person, the Participant says "I don't know about any of these".
09/07:00	VO	Printer starts in the background.
09/07:14	VO	Person writes some information into the printout of the handover system.
09/07:42	VO	Person takes a device out of her pocket and checks the screen.
09/07:50	VO	Person turns. Her back is now towards the screen of the handover system.
09/08:31	VO	Person checks watch.
09/08:39	VO	Split of handover into two. None of the handovers uses the handover system.
09/09:32	VO	Person hands over patients by reading the information from the screen of the handover system.
09/09:57	VO	Two people taking notes during the handover.
09/10:54	VO	Person verbally confirms and then writes down the BMI of a patient.
09/12:39	VO	Person is working on an computer other than the handover system.

Table A.10

Log file from 9th user observation (initial handover environment)(continued)

Handover Observation - 29-April 2011 / 08:00-08:36 / File 29 4.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
09/13:21	VO	Person is entering some information into the handover system computer.
09/14:07	VO	Person is asking for some information to be repeated.
09/14:53	VO	Person leans forward in order to read screen of handover system.
09/15:39	VO	Person refers back to a paper in order to handover a particular patient.
09/15:40	VO	Mobile phone of Handover Participant rings.
09/17:55	VO	Some confusion about which patients to hand over. Person handing over patients seems to switch to another view in the handover system.
09/18:56	VO	Phone rings in the background.
09/19:08	VO	Person hands over patient entirely from memory.
09/20:19	VO	Person is searching for some information on another computer.
09/20:42	VO	Person is looking at a sheet and enters information into the other computer.
09/21:17	VO	Person leans forward in order to read screen of handover system.
09/21:24	VO	Two people discuss a paper in the background.
09/21:45	VO	Person is asked about the babies weight and refers to his paper.
09/22:29	VO	Person verbally confirms some information with Person
09/24:59	VO	Person looks away, seems to be distracted.
09/25:36	VO	Person is handing over a patient. Looks at the handover system in order to know which patient to handover, starts handover from memory and then is searching for some information on another computer.
09/25:44	VO	Person leans forward in order to read screen of handover system.
09/26:34	VO	Person leans forward in order to read screen of handover system and other persons paper.
09/26:56	VO	Person is asked for some information by Person. Does not seam to know the answer.
09/27:10	VO	Person confirms that she does not know the information she's being asked for.
09/27:35	VO	Person leans forward towards the camera in order to read some information.
09/30:07	VO	Phone rings in the background.
09/31:36	VO	Person confirms that he does not know the information he's being asked for.
09/32:16	VO	Person writes on the whiteboard in the background.
09/32:49	VO	Person mentions that she rings someone up in order to find out about a baby.
09/33:24	VO	Multiple discussions.
09/33:34	VO	Person confirms some information from system other than the handover system.
09/33:58	VO	Person confirms that he does not know much about gynaecology patients.
09/34:15	VO	Person mentions that someone missed the handover.
09/34:19	VO	Someone (not visible) interrupts the handover, asking for some information.
09/35:42	VO	Handover ends.

Table A.11

Log file from 10th user observation (initial handover environment)

Handover Observation - 3-May 2011 / 08:00-08:09 / File 3 May.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
10/00:03	VO	Incoming SMO is inquiring as to who is still missing at the handover.
10/00:15	VO	Incoming SMO is confused as to which person held/holds which role.
10/00:31	VO	Person is writing contact information on Whiteboard in the background.
10/01:34	VO	Formal handover seems to start.
10/01:44	VO	Outgoing Registrar begins handover by reading information from the screen of the handover system.
10/01:53	VO	Incoming Registrar takes handwritten notes on printout of handover system.
10/02:15	VO	Phone rings in the background. Incoming SMO looks at the phone.
10/02:19	VO	Incoming SMO picks up the phone.
10/02:38	VO	Outgoing Registrar hands over a patient from memory.
10/04:00	VO	Incoming and Outgoing Registrar (who were sitting in front of the handover system) stand up and move to the back of the room.
10/04:08	VO	Person (not visible) starts handing over patients.
10/05:13	VO	Person sits down in front of handover system but does not face it.
10/05:32	VO	Person confirms that some verbal information could not be understood.
10/06:01	VO	Outgoing Registrar is providing additional information about a patient from memory.
10/06:32	VO	Handover entirely switched away from the handover system.
10/06:58	VO	Person confirms that the only reason why she knows about a particular patient is because she met another staff member in the elevator.
10/07:08	VO	Person is pointing at the whiteboard and mentions that she does not know whether the information is current.
10/07:40	VO	Official Handover seems to be complete.
10/08:59	VO	Person (not visible) hands over some information about available beds.

Table A.12

Log file from 11th user observation (initial handover environment)

Handover Observation - 4-May 2011 / 08:00-08:26 / File 4 May.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
11/00:05	VO	Confirmation that one member (Registrar) from WAU is missing.
11/00:16	VO	Bell rings in the background
11/00:27	VO	Printer starts in the background.
11/00:37	VO	Person is handing over patients while looking away from the handover system.
11/00:51	VO	Person looks back, is disturbed by the printer.
11/01:16	VO	Person is looking engaged with her mobile phone.
11/02:36	VO	Printer starts in the background.
11/04:07	VO	Printer starts in the background.
11/05:40	VO	Person mentions that she hasn't recorded some information.
11/06:01	VO	Registrar from WAU arrives at the handover.
11/07:22	VO	Discussion as to which patient group should be handed over next.
11/07:45	VO	Person (not visible in video) is handing over patients while not in front of the handover system.
11/10:26	VO	Person (not visible in video) is handing over patients while not in front of the handover system. Hands visible, indicating that he is handing over from memory.
11/14:17	VO	Person leans forward in order to read from screen of the handover system.
11/14:53	VO	Outgoing registrar confirms that she hasn't written down specific information.
11/15:25	VO	Person starts working on the computer in the background.
11/15:52	VO	Phone rings in the background.
11/17:03	VO	Person hands over patient from Memory.
11/18:11	VO	Person leans forward in order to read from screen of the handover system.
11/19:19	VO	Second outgoing registrar confirms that she hasn't any information about a particular patient.
11/19:52	VO	Second outgoing registrar asks another handover participant for information about patient. Other person starts handing over patient from memory and notes.
11/25:53	VO	Person mentions that a patient "is not admitted properly on the computer".

Table A.13

Log file from 12th user observation (initial handover environment)

Handover Observation - 5-May 2011 / 08:00-08:23 / File 5 May.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
12/01:20	VO	Bell rings in the background
12/01:25	VO	Outgoing registrar is referring to the handover system by saying "the rest is on the board".
12/01:34	VO	Unclear as to which person should handover a particular patient.
12/02:41	VO	Outgoing registrar is pointing at the handover system, it looks like she has seen some information that she wants to handover.
12/04:16	VO	Outgoing registrar confirms that he does not know anything about two patients.
12/04:55	VO	Outgoing registrar asks whether anyone knows anything about a particular patient.
12/05:10	VO	Outgoing registrar leans forward in order to find some information on the screen of the handover system
12/05:11	VO	Person points to the screen of the handover system in order to assist the outgoing registrar.
12/06:25	VO	People speaking at the reception in the background.
12/07:15	VO	Person is entering some information into the handover system computer.
12/07:23	VO	Bell rings in the background
12/07:51	VO	Person is confirming some information about a patient from a computer in the background.
12/08:18	VO	Person arrives late at the handover.
12/08:44	VO	Person leans forward in order to read from screen of the handover system.
12/09:03	VO	Outgoing consultant takes a printout of the handover system out of her pocket.
12/09:21	VO	Outgoing registrar starts to handover a patient. Reads information from the printout of the handover system.
12/09:26	VO	Person leaves handover.
12/10:08	VO	Person reads information from the whiteboard with staff information and writes it down.
12/11:27	VO	Printer starts in the background.
12/11:32	VO	Person leans forward in order to read screen of the handover system.
12/12:49	VO	Second outgoing registrar confirms that she hasn't written down specific information.
12/13:08	VO	Phone rings in the background.
12/13:30	VO	Phone rings in the background.
12/13:31	VO	Outgoing registrar is referring to the handover system by saying "read the notes anyway".
12/14:44	VO	Person is pointing at the screen of the handover system.
12/15:27	VO	Mobile phone / pager of outgoing registrar rings.
12/15:49	VO	Second outgoing registrar starts to handing over a patient. Reads information from the printout of the handover system.
12/16:05	VO	Bell rings in the background
12/16:48	VO	Person writes information on the whiteboard with staff information while the handover continues.
12/17:31	VO	Second outgoing registrar starts to handing over a patient. Reads information from the screen of the handover system.
12/18:14	VO	Person arrives late at the handover.

Table A.14

Log file from 12th user observation (initial handover environment)(continued)

Handover Observation - 5-May 2011 / 08:00-08:23 / File 5 May.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
12/18:40	VO	Person in the background (not visible) starts to handover another patient.
12/19:10	VO	Person starts working on the computer in the background.
12/19:58	VO	Outgoing Registrar says "done?". Indication that handover ends.
12/20:31	VO	Person (who arrived at 18:14) looks at the screen of the handover system and starts to ask questions.
12/20:46	VO	Person leans forward in order to read from screen of the handover system.
12/21:32	VO	Person seems to be distracted by discussion in the background.
12/22:46	VO	Person request more information by saying "tell me what's happening here Sarah, please".

Table A.15

Log file from 13th user observation (updated handover environment)

Handover Observation - 5-September 2011 / 08:00-08:21 / File 5 09 11.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
13/01:16	VO	Handover starts with introductions.
13/02:20	VO	Person arrives late at the handover.
13/02:24	VO	Person mentions that the handover is meant to start at 8am.
13/03:03	VO	Three out of Seven people sitting at the table taking notes.
13/05:16	VO	Person handing over patients is looking briefly at the screen of the handover system.
13/06:02	VO	Person handing over patients is again looking briefly at the screen of the handover system in order to be reminded of the next patient.
13/06:14	VO	Handover of patients in another unit starts. Three people on the screen physically change the sheet on their printout.
13/06:22	VO	Person handing over patients asks another person to change the screen on the handover system in order to see the patients from the other unit.
13/06:36	VO	Person is noting down some information while looking at the screen of the handover system. Does not seem to listen to the information that is being handed over at the same time.
13/11:26	VO	Handover of patients in another unit starts (Inductions). Three people on the screen physically change the sheet on their printout.
13/11:35	VO	Person changes screen on the handover system in order to see the patients from the other unit.
13/11:41	VO	Person handing over patients admits that she does not know much about a particular patient.
13/12:05	VO	Mobile phone of person attending the handover rings. Person starts talking at the phone.
13/12:59	VO	Mobile phone of person attending the handover rings. Person starts talking at the phone.
13/13:08	VO	Person enters room.
13/13:20	VO	Person who just enters room goes to the table and grabs a printout of the handover system.
13/13:55	VO	Person who does the handover is asked about a baby's size. She opens a folder in order to look up the information.
13/14:12	VO	Folder is handed over to another person who starts looking at the information.
13/18:04	VO	Person mentions that she has just received a call from some other medical staff about a patient to be handed over. Patient is on the list as she is pointing to it.
13/21:00	VO	Handover ends.

Table A.16

Log file from 14th user observation (updated handover environment)

Handover Observation - 6-September 2011 / 08:00-08:25 / File 6 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
14/00:25	VO	Uncertainty on which patients to handover first.
14/00:55	PO	Person who hands over speaks very quietly.
14/01:30	PO	Person is arriving late at the handover.
14/02:02	PO	Person who hands over reads from printout of the handover system that contains many personal notes.
14/a	PO	Five out of Seven people sitting at the table have a printout of the handover system in front of them.
14/03:15	PO	"Update" message appears on the screen of the handover system.
14/04:01	PO	Person is looking at the screen.
14/04:29	PO	Person sitting at the table is leaning forward slightly in order to read information from the screen of the handover system.
14/04:30	VO	Confusion about a patient. Three people look at the screen of the handover system in order to verify.
14/05:42	PO	Person arrives late at the handover.
14/b	PO	It is not believed that the people sitting on the sofa can read the information on the screen of the handover system.
14/07:43	VO	Person handing over patients cannot remember at what time a particular patient has been admitted to the hospital.
14/08:15	PO	"Update" message appears on the screen of the handover system.
14/08:30	VO	Person changes screen on the handover system in order to see the patients from the other unit.
14/08:58	PO	Person is looking at a printout that is NOT the printout from the handover system.
14/10:09	PO	It appears that some information about a patient is missing.
14/10:16	VO	Person enquiries about a patients name and notes it down.
14/10:37	PO	Person is arriving late at the handover.
14/12:52	PO	Person states that she "cannot remember" some information.
14/12:57	PO	People arrive late at the handover.
14/13:02	VO	Phone rings in the background.
14/c	PO	People handing over patients never refer to the room number. Hence, people cannot refer to the person by looking at the screen of the handover system.
14/13:44	PO	There is talk about a patient who's name cannot be remembered by anyone.
14/15:12	VO	Person says "you didn't get much handed over either".
14/15:19	PO	Person is looking at a printout that says "Theatre List".
14/15:49	VO	Person is leaning forward in order to read from the screen of the handover system.
14/17:25	VO	Disagreement about some medical information concerning a patient. It is then concluded that one person was referring to another patient.
14/21:23	VO	Person hands over a paper to another person.
14/21:25	PO	Name of Patient who is mentioned at the handover is not seen on the screen.
14/22:15	PO	Person is looking at a printout that says "Theatre List".
14/23:20	PO	Person who is speaking is looking at the screen of the handover system.
14/25:05	PO	Handover ends.

Table A.17

Log file from 15th user observation (updated handover environment)

Handover Observation - 7-September 2011 / 08:00-08:17 / File 7 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
15/00:50	VO	Mention that representative operating theatre and charge midwife are not present at the handover.
15/00:58	VO	Person who hands over asks another staff member to highlight a patient on the screen of the handover system.
15/01:09	PO	Person who hands over mentions room number, allowing other members to view details on the screen.
15/01:20	VO	People arrive late at the handover.
15/01:56	PO	One patient on the screen of the handover system is highlighted. However, it is not the patient currently being handed over.
15/02:48	PO	Midwife writes something on the whiteboard on the wall.
15/03:29	VPO	Phone rings in the background. Midwife starts phone conversation.
15/a	PO	Seven out of eight people sitting at the table have a printout of the handover system in front of them.
15/03:40	VO	Person who hands over is pointing at the screen of the handover system.
15/04:15	VO	Phone rings in the background.
15/05:34	VPO	Person enters data into the handover system.
15/05:48	VO	All eight persons sitting on the table look at the screen of the handover system.
15/06:59	PO	Doctor of the incoming shift takes notes onto a paper.
15/08:19	VO	Person enters data into the handover system.
15/08:30	PO	Outlying patient do not seem to be recorded in the handover system.
15/08:42	VO	Person doing the handover is asked to speak up.
15/09:02	PO	The information about a patient is read from a printout that is NOT the printout from the handover system.
15/10:36	PO	The spreadsheet of the handover system is changed.
15/10:46	VPO	Person interrupts the handover in order to discuss a patient of concern.
15/11:44	VPO	Person dong the handover is reading from the Handover quickguide, then asks for patient that can be expected at the unit and is looking around the room.
15/12:15	VO	Handover changes to inductions. Person doing the handover of the inductions is quickly looking at the screen of the handover system for a couple of times.
15/12:23	PO	Person who hands over looks at the screen of the handover system and mentions room number.
15/13:32	VPO	Phone of the midwife rings.
15/16:09	VPO	Person leaves handover.
15/b	PO	Person attending handover had the Handover quickguide in front of her.
15/17:18	VO	Handover ends.

Table A.18

Log file from 16th user observation (updated handover environment)

Handover Observation - 8-September 2011 / 08:00-08:28 / File 8 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
16/00:01	VO	Person changes view on the screen of the handover system.
16/01:01	VO	Introduction at the start of the handover.
16/01:28	VO	One person sends apologies from another person that cannot attend the handover.
16/02:20	VO	Incoming WAU consultant looks at the screen of the handover system. Needs to look over the shoulder to properly see the screen.
16/05:08	VO	The spreadsheet of the handover system is changed.
16/06:33	VO	Outlying patient do not seem to be recorded in the handover system. Person who hands over reads from a printout that is not the one from the handover system.
16/06:49	VO	Phone rings in the background.
16/07:57	VO	Incoming WAU consultant does not have a patient's name.
16/08:27	VO	Incoming WAU consultant starts a phone conversation.
16/10:26	VO	Incoming WAU consultant request change in process as who to be handed over next.
16/11:15	VO	Phone rings in the background.
16/12:47	VO	Incoming WAU consultant says "so what's next" while looking at the screen of the handover system.
16/12:55	VO	Incoming WAU consultant turns towards the screen of the handover system.
16/14:11	VO	Outgoing DU registrar looks at the screen of the handover system in order to be reminded of the next patient to be handed over.
16/16:37	VO	Incoming WAU consultant frequently looks at the screen of the handover system while handing over / discussing a patient.
16/17:57	VO	Outgoing WAU Registrar marks something on a paper in front of her and then pushes the paper towards the incoming WAU consultant.
16/20:48	VO	Person does not know answer to the question being asked (whether patient has appointment booked).
16/21:02	VO	Outgoing DU registrar receives notification on mobile phone.
16/24:35	VO	Incoming DU registrar leaves handover temporarily.
16/24:36	VO	Phone rings in the background.
16/24:42	VO	Outgoing DU registrar leaves handover temporarily.
16/25:37	VO	Person asks whether there are any other patients that they need to know about.
16/28:28	VO	Handover ends.

Table A.19

Log file from 17th user observation (updated handover environment)

Handover Observation - 9-September 2011 / 08:00-08:24 / File 9 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
17/01:16	VO	Informal handover before official start.
17/01:23	VO	Person changes between screens on the handover system.
17/03:02	VO	Persons apologises for other people who cannot attend the handover.
17/03:40	VO	Introduction stopped after first person.
17/05:17	VO	Person handing over mentions that she does not know anything about a particular patient.
17/05:52	VO	The spreadsheet of the handover system is changed.
17/08:12	VO	Person looks at the screen of the handover system in order to be reminded of the next patient to be handed over.
17/08:16	VO	Person handing over mentions that she does not know much about a particular patient.
17/09:12	VO	Person arrives late at the handover.
17/09:57	VO	Confusion about which patients to handover. Person is pointing at the handover system and says "can we finish those?".
17/10:37	VO	Person starts a phone conversation.
17/12:04	VO	The spreadsheet of the handover system is changed.
17/13:30	VO	Person seems to be missing information about already handed over patients.
17/14:30	VO	Person asks as to which patients to hand over next.
17/18:35	VO	Pager of person attending the handover sounds.
17/19:35	VO	Person does not know answer to the question being asked (patients BMI).
17/20:16	VO	Person mentions that he "cannot talk because of the camera".
17/22:00	VO	Discussion about the whiteboard which does not seem to be filled in.
17/22:50	VO	Person starts a phone conversation.
17/23:55	VO	Handover ends.

Table A.20

Log file from 18th user observation (updated handover environment)

Handover Observation - 12-September 2011 / 08:05-08:17 / File12 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
18/a	PO	Before the handover, two people mention that a previous handover did not go well and attribute this to the fact that the treatment of the patients did not follow "standard procedure".
18/b	PO	Person enters room. When she sees camera, she says "oh, we are recorded, I am going to sit on the other side of the table [i.e. back facing camera]."
18/c	PO	Person attending handover had the "chips card" in front of her.
18/d	PO	Handover starts approximately 5 minutes late.
18/e	PO	Date on the whiteboard in the back of the room is not current.
18/03:56	VO	Person rings another person in order to check whether he/she attends the handover.
18/06:04	VPO	Spreadsheet on the handover system needs to be changed as it shows the wrong patients.
18/f	PO	Five out of seven people sitting at the table have a printout of the handover system in front of them.
18/g	PO	Four people in the room taking notes on printout of the handover system.
18/06:15	VO	Six out of seven people sitting at the table look at the screen of the handover system.
18/06:50	VO	Person handing over patients mentions that they are searching a form which contains a patients medical information.
18/07:21	VO	Person arrives late at the handover.
18/09:18	VPO	Second discussion starts at the table.
18/09:50	PO	Person leaving room after receiving a phone call.
18/10:43	VPO	Person highlights patient that is handed over on the handover system.
18/10:56	VO	Incoming DU consultant requests change in process as who to be handed over next.
18/11:37	PO	Information handed over is NOT presented on the screen of the HO system.
18/11:55	PO	Update message appears on the screen of the handover system. After the update, the previously highlighted patient (see 18/11:37) is no more highlighted.
18/13:02	VO	Screen of the handover system is changed in order to handover HDU patients.
18/13:29	PO	Person beside observer leans forward in an attempt to read some information on the screen of the handover system.
18/14:06	PO	Information handed over is NOT presented on the screen of the handover system (amount of blood a patient has lost).
18/15:00	PO	The information about a patient is read from a printout that is NOT the printout from the handover system.
18/15:29	VO	Incoming DU consultant asks about patients that are waiting of theatre. These patients seem not to be recorded in the handover system.
18/15:35	PO	Person beside observer is showing the participants of the handover a paper printout that is NOT the printout of the handover system.
18/15:41	VO	Incoming DU consultant asks about patients that are in recovery. These patients seem not to be recorded in the handover system.
18/15:52	VPO	Screen on the handover system is changed in order to handover the "inductions".
18/16:47	VPO	Handover ends.

Table A.21

Log file from 19th user observation (updated handover environment)

Handover Observation - 13-September 2011 / 08:00-08:19 / File13 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
19/00:06	VO	Handover starts with introduction.
19/00:57	VO	Person who hands over patients looks at the screen of the handover system while handing over patients.
19/01:06	VO	Two people start taking notes.
19/01:26	VO	Outgoing DU registrar excuses herself for not having the details of a patient on the printout of the handover system nor on memory.
19/01:29	VO	Outgoing DU registrar looks at the screen of the handover system and asks a colleague to "click on the Progress" in an attempt to find the missing details about a patient (see 19/01:26).
19/02:05	VO	Indication that outgoing DU registrar uses handover system only as reference and that handed over information is not displayed on the screen of the handover system (confusion about 6cm vs 9cm. If the information was shown on the screen of the handover system, then outgoing DU registrar would likely not have been asked to reconfirm this information).
19/02:38	VO	Update message appears on the screen of the handover system. After the update, the previously highlighted patient is no more highlighted.
19/05:06	VO	Midwife leaves handover.
19/05:46	VO	Indication that information handed over is NOT presented on the screen of the handover system as the outgoing DU Registrar had to re-confirm with the outgoing WAU Registrar (whether patient had blood products).
19/06:54	VO	Screen of the handover system is changed in order to handover DCC patients.
19/07:46	VO	Outgoing DU Registrar does state that she does not know some information (Time of a patients C-Section).
19/08:38	VO	Outgoing DU Registrar refers to a paper brought by the outgoing WAU Registrar in order to handover outlying patients.
19/08:57	VO	One more outlying patient is handed over that seems neither be recorded in the paper brought by the outgoing WAU Registrar nor on the screen of the handover system.
19/09:24	VO	Person handing over patient states that she does not know the patients surname.
19/10:30	VO	Incoming DU Consultant is given a paper with information while a patient is handed over to her.
19/11:20	VO	Paper given to incoming DU Consultant (see 19/10:30) is NOT printout from the handover system.
19/15:32	VO	Person leaves handover early.
19/16:12	VO	Person handing over patient states that she does not know anything about a particular patient.
19/17:56	VO	Person handing over patient states that she does not has specific information about a particular patient. He is asked to obtain the information from the hospital where the patient has been sent from.
19/19:10	VO	Handover ends.

Table A.22

Log file from 20th user observation (updated handover environment)

Handover Observation - 14-September 2011 / 08:00-08:26 / File14 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
20/00:15	VO	Outgoing WAU Registrar consults handover quickguide in order to be reminded of the correct step of the Handover process (Staffing)
20/01:09	VO	Outgoing WAU Registrar consults handover quickguide in order to be reminded of the correct step of the Handover process (High Risk patients)
20/01:16	VO	WAU consultant corrects outgoing WAU Registrar and mentions that the Staffing part of the Handover process in not completed.
20/01:40	VO	Midwife arrives late at the handover.
20/03:26	VO	Screen of the handover system is changed in order to handover HDU and DCC patients.
20/06:40	VO	Three people sitting on the table taking notes.
20/07:30	VO	Outgoing DU Registrar, who has done the handover of the HDU and DCC patients, has never looked at the screen of the handover system (handover mainly from paper in front of her).
20/09:59	VO	Outgoing DU Registrar mentions that she does not remember some information about a patient.
20/10:43	VO	Two people lean forward in order to read some information from a paper lying on the table.
20/12:26	VO	Outgoing WAU Registrar consults handover quickguide in order to be reminded of the correct step of the Handover process.
20/12:31	VO	Screen of the handover system is changed.
20/17:01	VO	Outgoing DU Registrar mentions that she does not remember some information about a patient.
20/17:14	VO	Indication that information handed over is NOT presented on the screen of the handover system as the outgoing DU Registrar had to re-confirm with another person attending the handover (time a patient had a c-section).
20/19:09	VO	Indication that outgoing WAU registrar uses handover system only as reference and that handed over information is not displayed on the screen of the handover system (As she mentions that a patient "must be new, I don't know who she is").
20/20:18	VO	Outgoing WAU Registrar does not remember some information about a patient (How many days ago the patient had a c-section).
20/24:29	VO	Person who hands over is pointing at the screen of the handover system.
20/25:43	VO	Person who hands over is frequently looking at the screen of the handover system in order to be recalled of detailed information about a patient that needs to be mentioned.
20/26:14	VO	Handover ends.

Table A.23

Log file from 21st user observation (updated handover environment)

Handover Observation - 15-September 2011 / 08:00-08:18 / File15 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
21/00:08	VO	Handover starts with introduction.
21/a	VO	Only four people sitting at the table. Usually, there were 6-7 people sitting there.
21/01:00	VO	Person handing over patients mentions that some information given is "according to the midwifes notes".
21/01:47	VO	Person handing over patients briefly looks at the screen of the handover system and then continues to look at the paper in front of her.
21/02:38	VO	Person arrives late at the handover.
21/03:14	VO	Phone rings in the background.
21/04:49	VO	Person who just handed over takes a list that lies in front of the incoming WAU consultant.
21/07:50	VO	Person arrives late at the handover.
21/07:55	VO	Person changes screen of the handover system.
21/08:55	VO	Person handing over apologises that she does not know any of the inductions.
21/12:45	VO	Person handing over patients mentions that she is "pretty sure about the dates, just from memory".
21/16:06	VO	Person handing over patients mentions that she just checked some information before the handover.
21/16:27	VO	Phone rings in the background.
21/17:21	VO	Person handing over patients mentions that she does not know anything about a patient since the patient just came into the unit.
21/18:13	VO	Handover ends.

Table A.24

Log file from 22nd user observation (updated handover environment)

Handover Observation - 16-September 2011 / 08:00-08:22 / File16 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
22/00:12	VO	Handover starts with introduction.
22/00:58	VO	Incoming DU Consultant consults handover quickguide in order to be reminded of the correct step of the Handover process (Bed status)
22/01:06	VO	Bed status is captured on a whiteboard as opposed to the handover system.
22/01:19	VO	Person arrives late at the handover.
22/01:25	VO	Patient is being highlighted on the screen of the handover system.
22/01:56	VO	Incoming DU consultant looks at the screen of the handover system. Needs to turn and look over the shoulder to properly see the screen.
22/02:13	VO	Incoming DU Registrar highlights one field for a patient other then the already highlighted one.
22/02:41	VO	Handover switches from one patient (room) to another. However, the highlighted patient on the screen of the handover system is not changed.
22/02:44	VO	Phone of the Clinical Charge Midwife rings.
22/04:00	VO	Phone of the Clinical Charge Midwife rings. She picks up the phone and starts conversation.
22/04:28	VO	Three out of eight people at the table (all incoming shift) take notes while a patient is being handed over.
22/04:53	VO	Handover switches to HDU. Spreadsheet of the Handover system is changed.
22/05:33	VO	Person arrives late at the handover.
22/06:22	VO	Outgoing DU registrar mentions that she tried to call the on-call obstetrics in order to obtain some information about a patient. However, the obstetrics did not pick-up the call.
22/06:33	VO	Outgoing DU registrar does not know answer to question being asked (amount of Aspirin given to a patient).
22/07:48	VO	Spreadsheet of the handover system is changed.
22/08:57	VO	Incoming DU consultant points at the camera and says "it's for the purpose of that…"
22/09:30	VO	Indication that patient being handed over (in ICU) is neither available on the screen of the handover system nor on the papers (handover system printouts) in front of the participants.
22/10:50	VO	Incoming WAU Registrar mentions that there were some "Bad feelings between the departments".
22/11:38	VO	Indication that patient being handed over (outlying patient in MFN) is neither available on the screen of the handover system nor on the papers (handover system printouts) in front of the participants.
22/12:00	VO	Patient is being highlighted on the screen of the handover system.
22/12:30	VO	Incoming DU Consultant asks a person (not in the screen) whether a patient is the "one she has been talking to Kathy this morning".
22/12:34	VO	Confusion about a patient.
22/13:17	VO	Incoming DU Consultant mentions that he is still confused about how many patients from theatre he and his team are responsible for.

Table A.25

Log file from 22nd user observation (updated handover environment)(continued)

Handover Observation - 16-September 2011 / 08:00-08:22 / File16 09 2011.wmv (Observation logs in chronological order)		
#&Time	Type	Observation / Comment
22/14:28	VO	Indication that patient being handed over (person coming into WAU) is neither available on the screen of the handover system nor on the papers (handover system printouts) in front of the participants.
22/15:18	VO	Person is told that she can leave handover if she wishes. She is leaving handover.
22/16:35	VO	Handover switches to Inductions. Patient is being highlighted on the screen of the handover system.
22/17:37	VO	Incoming DU Registrar looks and points at the screen of the handover system and then writes some information on the paper in front of her.
22/18:33	VO	Outgoing WAU Registrar hands over patients. She looks at the screen of the handover system while doing handover. Incoming DU Registrar highlight patients being handed over on the screen of the handover system.
22/18:42	VO	Outgoing WAU Registrar mentions that she does not know why a patients who just arrived has been delivered to the WAU.
22/19:23	VO	Outgoing WAU Registrar is looking away from the screen of the handover system to the other participants and starts handing over details of a patient from memory.
22/19:52	VO	Outgoing WAU Registrar asks Incoming DU Registrar to highlight the next patient on the screen of the handover system.
22/20:01	VO	Phone of the Outgoing DU Registrar rings. She picks up the phone, starts conversation and leaves the room.
22/21:20	VO	Phone of the Incoming WAU Registrar rings. She picks up the phone and starts conversation.
22/22:02	VO	Video ends. Handover does not seem to be completed.

Appendix B: Log files from stakeholder interviews

Table B.1

Log file from 1st stakeholder interview

Handover Observation - 11-Mar 2011 Logs from Interview with two users about the Initial Handover System	
#	Log
0.1	[User 1] The system should display current patients and patients in the HDU on the same screen.
0.2	[User 1] The column "Nutrition" is regarded as superfluous as it is nearly never populated.
0.3	[User 1] The column "Nutrition" is regarded as a duplicate of the column "Diet".
0.4	[User 1] Pool rooms are not listed.
0.5	[User 1] The fact that patients in the WAU Unit can be viewed is regarded as a good feature.
0.6	[User 1] The column "Injury" is regarded as superfluous.
0.7	[User 2] The system should have another tab which shows potential patients which are currently in other units.
0.8	[User 2] The entries in the "Comments" column can be changed. It is felt that these comments should be shown in a historical view, without the possibility to change comments.

Table B.2

Log file from 2nd stakeholder interview

Stakeholder Interview - 11-April 2011 Registrar O&G		
#	Question	Answer
1.1.1	What is your definition of clinical handover?	Transform of information about a patient from one primary care worker to another.
1.1.2	What are the functions of clinical handover?	To ensure that all valid information is passed over. Ensure that their ongoing treatment and safety continuous.
1.1.3	What do you think the transferring of responsibility and accountability during handover means?	Transferring from one worker to the next to ensure that the continuity of care continuous.
1.2.1	Can you please discuss how handover is currently conducted in your department?	Handover formally takes place at two set times at 08:00 and 22:00 hours. All patients that are at high risk (i.e. in Labour or sent to acute) are handed over plus any patients of concern. The on call teams both from the night and the morning are involved with that handover. It's registrar led with consultant input. Other parties who attend are the Anaesthesiologists and Charge Midwifes.
1.2.2	What do you think are the positive aspects of your current handover process?	It generally runs on time. Each individual tends to have a structured process they follow themselves. Relaxed environment, there is not a great deal of tension.
1.2.3	What do you think are the negative aspects of your current handover process?	The lack of structure, so information has a great potential of being lost. The lack of set handover. The lack of IT support (patients, e.g. outliers can be lost in the process). The environment where the handover takes place is quite disruptive and noisy. Lack of training so that the doctors actually know what is required to handover.
1.2.4	How do you think your current handover process could be improved?	Three things that need to change: 1) The environment needs to change so that there is less disruption. 2) The process needs to be more structured, the introduction of a pro forma would help. 3) The current IT and software being used needs to be updated and more specific to the needs of G&O patients.
1.2.5	What information do you require for continuity of patient care during your shift?	Good background of the patient, including medical background, medicines, surgery, history, current situation, risk points, whether they labouring or why they are on the labour unit, changeable parameters, whether they need to go to the theatre including teams that need to be notified of their arrival. Minimal dataset needs to be known. Currently, there is no min. dataset.
1.2.5	How could information technology help you with handover?	It is a very dynamical environment, particularly on the labour ward. So it would be helpful if the basic facts could be recorded correctly and quickly. Information should be easily accessible and changed.
1.3.1	How did you learn how to do handover?	It was never formally taught, it is a process that you learn on the job. And you learn by your mistakes if something goes wrong.
1.3.2	How do you think handover should be taught?	It would be helpful to have formal teaching of handover, using pro formas.

Table B.3

Log file from 3rd stakeholder interview

Stakeholder Interview - 3-May 2011 Charge Midwife		
#	Question	Answer
2.1.1	What is your definition of clinical handover?	Passing over all the relevant information for each patient.
2.1.2	What are the functions of clinical handover?	To make sure that patients get the correct care for that day.
2.1.3	What do you think the transferring of responsibility and accountability during handover means?	It means that one shift is handing all of that over to the next shift.
2.2.1	Can you please discuss how handover is currently conducted in your department?	Giving basic information, organising what's most important for the morning. Trying ot avoid people being missed from different departments (e.g. outliers).
2.2.2	What do you think are the positive aspects of your current handover process?	Everybody knows everybody. There is generally a consultant leading it. You have the opportunity to say things that need to be said and be involved in it.
2.2.3	What do you think are the negative aspects of your current handover process?	In a noisy room with constant interruptions. The printer is the worst, it's loud. And there is no structure for things we all need to know, like I had to know about a woman who came from the ward but nobody has told me about.
2.2.4	How do you think your current handover process could be improved?	Less interruptions, quieter room and more structured way of knowing every patient we need to know about. We often have missing bits that we find out later.
2.2.5	What information do you require for continuity of patient care during your shift?	Categorising who is the most important. That's probably the biggest one, personally for me. Managing the patient flow.
2.2.6	How could information technology help you with handover?	Having somewhere to display where everybody is. The current whiteboard (non electronically) is badly updated. Having a list of women who need to come to delivery unit, including a priority in which they need to come.
2.3.1	How did you learn how to do handover?	Through repetition, standing in there and doing it.
2.3.2	How do you think handover should be taught?	There could be a process of handover that could be formally taught.
2.4	How could the current spreadsheet be improved?	It should include all the outlying patients, including priority. The structure is good though. However, the doctors want information such as BMI in there. Or risk factors. There is not too much information on the spreadsheet, all is used.

Table B.4

Log file from 4th stakeholder interview

Stakeholder Interview - 4-May 2011 Registrar		
#	Question	Answer
3.1.1	What is your definition of clinical handover?	It's the transfer of information about the patients from one shift to the next.
3.1.2	What are the functions of clinical handover?	The point is the oncoming team has all the information that they need.
3.1.3	What do you think the transferring of responsibility and accountability during handover means?	That's what we are doing. The oncoming team will be accountable and responsible so the outgoing need to make sure that they are fully informed in order to take that responsibility over.
3.2.1	Can you please discuss how handover is currently conducted in your department?	It could be improved on. Not particularly systematic at the moment. The idea is that all the patients are handed over. Normally, we start with DU and then go to WAU but the handover of outliers or the handover from other people who are concerned about patients like other teams or Anaesthetics, there is no system for handing those over and so it can get quite messy. In addition, there are also frequent interruptions, mostly people coming in late, people who need to use the room coming in, phone calls, people using the room for other purposes, like this morning, people using the photo copier and generally doing other work than handover.
3.2.2	What do you think are the positive aspects of your current handover process?	Generally, most patients hare handed over appropriately. The verbal transfer of information is normally appropriate and if not, there is always opportunity to clarify, so most of the patients on DU and WAU tend to be handed over in a way so that the oncoming team has enough information to do their job.
3.2.3	What do you think are the negative aspects of your current handover process?	Not having a systematic format and generally not having a robust way of handing over outliers or other patients of concern and being frequently interrupted by other people using the room.
3.2.4	How do you think your current handover process could be improved?	By minimising the interruptions and by having a more systematic format. It would be useful not to start until all the relevant people are there and having people more aware of the importance of handover because, at the moment, people do tend to arrive late but feel that their patient they want to handover is the most important and will interrupt halfway through and there is no kind of system that we all follow.
3.2.5	What information do you require for continuity of patient care during your shift?	We get most of the information that we require. Things that are important are the name and the age of the patient, if they are pregnant the station of their pregnancy, current problem or the reason they are coming in or what investigations have been done.

Table B.5

Log file from 4th stakeholder interview (continued)

Stakeholder Interview - 4-May 2011 Registrar		
#	Question	Answer
3.2.6	How could information technology help you with handover?	At the moment, the whiteboard has a lot of information on there that is not useful, which means that when you look at the computer screen, the information that is useful is often off the screen because what's on the screen is useless. Having a bigger display would be easier for handover because, in the current system, only 3-4 people can see the screen. And having a system to print the screen out.
3.3.1	How did you learn how to do handover?	By going to them, on the job.
3.3.2	How do you think handover should be taught?	In most situations, the people who are handing over are Registrars who have been house surgeons before who attended handovers. I think you pick up enough by watching handovers by see what you need to do. I guess a basic formal teaching wouldn't be a bad idea but I don't think it would be worth doing until someone is just ready. I wouldn't do it at med school.
3.4	How could the current spreadsheet be improved?	The most important box is the "patient" one and information is this column often disappears. For WAU, the most important box is the "Referral" one. Unless you reformat the screen, you don't have this information. The other information is fine to be there, but it should not take up so much room that you loose the important information. Sometimes, there is not enough information in the "comment" box. There is no boxes that is

Appendix C: Log files from heuristic evaluation

Table C.1

Log file from heuristic evaluation

#	Usability Aspect	Observation / Comment	Impact perception	Environ. E1	Environ. E2
HE-01	Visibility and system status	There is no line break functionality for the data fields. Hence, information that exceeds the column width is not visible in the user interface.	Negative	x	x
HE-02		All the information in a particular data field is presented whenever the curser stays on the field for 3-4 seconds.	Positive	x	x
HE-03		There is no line break in the data fields when all information is presented upon staying with the curser on the field for 3-4 seconds.	Negative	x	x
HE-04		The handover system display a hourglass icon if a transaction is ongoing.	Positive	x	x
HE-05		The menu for the handover system remains static and the user can access all the options from the same page.	Positive	x	x
HE-06		The handover system makes use of colour (e.g. capacity status or Anaesthetic) but does not rely on solely on colour.	Positive	x	x
HE-07	Match between system and real world	The handover system uses colour in an naturalistic way, e.g. red for warnings.	Positive	x	x
HE-08		There is some alignment between data display on the handover system and IBAAAR proforma as outlined on the laminated card given to the handover participants (e.g. order of information and used terminology). However, there are also some discrepancies (e.g. Order: Planned Management and Anaesthetic / terminology: 'Past Obstetric History' vs. 'Obstetric Hx'.)	Neutral		x
HE-09		The handover system presents information in a similar way than programs such a Microsoft excel. However, there are differences. For instance, only row but not columns can be marked. If the user clicks on the header of a column, it does not mark the column, but sorts it alphabetically.	Negative	x	x
HE-10		The slidebar of the handover system does not resemble many other programs. For instance, the slidebars with does not resemble the visible pages width in relation to the overall with of the spreadsheet. Also, clicking on the empty space on either side of the slidebar does not move the visible are by a full page.	Negative	x	x
HE-11	User control and freedom	The menu of the handover system does not provide 'undo' and 'redo' options.	Negative	x	x
HE-12	Consistency and standards	The handover system presents some of the information in the pre-populated data fields in an inconsistent way (e.g. 'age': '33y 5m' vs. '33yrs')	Negative	x	x
HE-13		The handover system is inconsistent in regards to selecting medical staff: 'Midwife' is a editable free-text field while 'CaseManager' is a populated by choosing from a searchable list.	Negative	x	x

Table C.2

Log file from heuristic evaluation (continued)

#	Usability Aspect	Observation / Comment	Impact perception	Environ. E1	Environ. E2
HE-14	Error prevention	The handover system allows certain data fields (e.g. 'Anaesthetic' or 'Medical Hx') to be populated, even though there is no patient assigned to this row. Error message is displayed ('Please select patient first'), however data remains in data field.	Negative	x	x
HE-15		The updated handover system has two columns with the header 'Warning'.	Negative		x
HE-16		The handover system does not allow the user to edit standardised information such as 'Patient Name', 'NHI' or 'Age'.	Positive	x	x
HE-17	Recognition rather than recall.	At no stage during use of the handover system, the evaluator had to remember information from one screen that had to serve as an input into another screen.	Positive	x	x
HE-18	Flexibility and efficiency of use	The handover system allows for addition of free text data fields without code changes to the handover system or underlying database.	Positive	x	x
HE-19		The handover system allows for addition of selection (i.e. drop down) data fields without code changes to the handover system or underlying database.	Positive	x	x
HE-20		Print view can be adjusted by administrator to meet users requirements.	Positive	x	x
HE-21		The handover system allows users to change the width of each column.	Positive	x	x
HE-22		The (user) adjusted width of the columns is reverted to the preset width each time the handover system synchronises data with the CMS database system.	Negative	x	x
HE-23	Aesthetic and minimalist design.	Some of the columns have not been populated for any patient in the views observed on the handover system during the heuristic evaluation (system had been loaded with live data from the previous year).	Negative		x
HE-24		The layout of the handover system menu bar is consistent for all users.	Positive	x	x
HE-25	Help users recognise, diagnose and recover from errors.	When exiting the 'bed manager' sub-application, the handover system presented a technical error message.	Negative		x
HE-26	Help and documentation	When choosing the 'Help Topics' menu option, an information window appears ('Will display the contents page of the help file'. Upon pressing 'OK', nothing happened.	Negative	x	x
HE-27		When choosing the 'Tip of the day' (Help) menu option, a message 'did you know… That the \\CmsDbAcc1\CMS$\current\options\tip.txt file was not found?	Negative	x	x

Appendix D: List of usability events

Table D.1

List of usability events (page 1)

ID	Environment 1	Environment 2	Usability Event	Assessment: Impact (perception)	Assessment: Area	Method(s) of discovery: User Observation	Stakeholder Interviews	Heuristic Evaluation
UE001	x	n/a	Printer starts in the background	Negative	Environment	x	x	
UE002	x	n/a	People (not handover participants) speaking in the background.	Negative	Environment	x	x	
UE003	x	n/a	People (not handover participants) work on pc in background.	Negative	Environment	x		
UE004	x	n/a	Bell sound in the background / Other unspecified background noise.	Negative	Environment	x	x	
UE005	x	x	Phone calls/texting by people participating in the handover (including ringing desktop or mobile phone that has not been picket up).	Negative	Environment	x		
UE006	x	n/a	Phone calls/texting by people not participating in the handover (including ringing desktop or mobile phone that has not been picket up).	Negative	Environment	x	x	
UE007	x	x	Person takes a device/pager out of his/her pocket and checks it.	Negative	Environment	x		
UE008	x		Person leans forward towards the camera in order to read some information.	Negative	Environment	x		
UE009		x	Handover starts late	Negative	Process	x		
UE010	x	x	Handover interrupted in order to discuss a patient and/or obtain some information from a handover participant.	Negative	Process	x	x	
UE011	x	x	Evidence of informal handover either prior to the beginning or after end of the formal handover.	Negative	Process	x		
UE012	x	x	Mention that a person missed to attend the handover.	Negative	Process	x		
UE013		x	Person is apologised for not attending the handover.	Negative	Process	x		
UE014		x	Person is contacted in order to verify whether she/he attends the handover.	Negative	Process	x		
UE015	x	x	Evidence that only a subset of required/usual participants is attending the handover.	Negative	Process	x		
UE016	x	x	Participants arrive late at handover. (No indication that their presence was not required beforehand. Includes arrival after participant left handover temporarily)	Negative	Process	x	x	
UE017	x	x	Participants leave handover early (temporarily or permanent). (No indication that their presence in no more required)	Negative	Process	x		

Table D.2

List of usability events (page 2)

ID	Environment		Usability Event	Assessment		Method(s) of discovery		
	1	2		Impact (perception)	Area	User Observation	Stakeholder Interviews	Heuristic Evaluation
UE018		x	Participants leave handover early (temporarily or permanent). (Indication that their presence in no more required)	Negative	Process	x		
UE019	n/a	x	Participants introduce themselves at the start of the handover.	Positive	Process	x		
UE020	x	x	Participants do not or only partially introduce themselves at the start of the handover.	Negative	Process	x		
UE021	n/a	x	Handover quickguide is consulted in order to be reminded of the handover process (overall).	Positive	Process	x		
UE022	x	x	Evidence that handover process (overall) is not clear.	Negative	Process	x		
UE023		x	Evidence that handover process (overall) has been changed.	Negative	Process	x		
UE024	x	x	Evidence that handover process (overall) is insufficient.	Negative	Process	x	x	
UE025	x	x	Evidence that handover process (overall) is insufficient (Uncertainty about patients that need to be handed over).	Negative	Process	x		
UE026	x	x	Evidence that handover process (for single or group of patients) is insufficient.	Negative	Process	x	x	
UE027	x	x	Evidence that handover process (for single or group of patients) is good.	Positive	Process	x	x	
UE028	x	x	Split of handover into multiple handovers/discussions.	Negative	Process	x		
UE029	x	x	Person hands over patient entirely (or largely) from memory.	Negative	Process	x		
UE030	x		Person hands over patient from paper (unclear whether printout of handover system).	Negative	Process	x		
UE031	x	x	Person hands over patient from paper (printout of handover system).	Negative	Process	x		
UE032		x	Person hands over patient from paper (printout not from the handover system).	Negative	Process	x		
UE033	x		Person hands over patient from paper (handwritten notes on plain paper).	Negative	Process	x		
UE034	x	x	Person writes down information that is being handed over on a paper (unclear whether printout of handover system).	Negative	Process	x		
UE035	x	x	Person writes down information that is being handed over on a paper (printout of the handover system).	Negative	Process	x		
UE036	x	x	Person writes down information that is being handed over on a paper (printout not from the handover system).	Negative	Process	x		

Table D.3

List of usability events (page 3)

ID	Environment 1	Environment 2	Usability Event	Assessment: Impact (perception)	Assessment: Area	Method(s) of discovery: User Observation	Method(s) of discovery: Stakeholder Interviews	Method(s) of discovery: Heuristic Evaluation
UE037	x		Person writes down information that is being handed over on a paper (handwritten notes on plain paper).	Negative	Process	x		
UE038	x	x	Person mentions that someone needs to be rung up in order to obtain the required information.	Negative	Information	x		
UE039		x	Person mentions that someone has been rung up in order to obtain the required information. However, information could not be obtained (person could not be contacted or did not have the information).	Negative	Information	x		
UE040	x	x	Person admits that she/he does not have any/much/enough information about a particular patient/ group of patients.	Negative	Information	x		
UE041		x	Evidence that person does not have any/much/enough information about a particular patient/ group of patients.	Negative	Information	x	x	
UE042	x		Person admits that she/he is uncertain about the information he/she handed over and that it needs to be verified.	Negative	Information	x		
UE043	x		Evidence that person is uncertain about information he/she handed over.	Negative	Information	x		
UE044		x	Data in handover system is automatically updated.	Positive	System	x		
UE045		x	Data update results in highlighted patient not being highlighted anymore.	Negative	System	x		
UE046		x	Correct patient is highlighted on the screen of the handover system.	Positive	System	x		
UE047		x	Incorrect patient is highlighted on the screen of the handover system.	Negative	System	x		
UE048	x	x	Person enters data into the handover system.	Positive	System	x		
UE049	x	x	Spreadsheet on handover system is changed. (Note: As for E1, this action is assumed when people interacted with the system through the mouse only. However, this is an assumption since the screen of the handover system was not visible.)	Positive	System	x		
UE050	x	n/a	Handover system is not working.	Negative	System	x		
UE051	x	x	Difficulties to read/view information on the screen of the handover system due to screen/text size.	Negative	System	x	x	
UE052		x	Difficulties to read/view information on the screen of the handover system due to screen location.	Negative	System	x		

Table D.4

List of usability events (page 4)

ID	Environ-ment		Usability Event	Assessment		Method(s) of discovery		
	1	2		Impact (perception)	Area	User Observation	Stakeholder Interviews	Heuristic Evaluation
UE053	x	x	Person points at the screen of the handover system.	Positive	System	x		
UE054	x	x	Participant(s) focus on the screen of handover system.	Positive	System	x		
UE055	x	x	Handover system is used explicitly in order to gain information that is not available elsewhere.	Positive	System	x		
UE056	x		Information handed over is available in the handover system (screen).	Positive	System	x		
UE057	x	x	Information handed over is not available in the handover system (screen).	Negative	System	x	x	
UE058			Information handed over is not correctly captured in the handover system (screen).		System	x		
UE059	x	x	Use of whiteboard instead of handover system	Negative	Process	x		
UE060	x	x	Person cannot be understood	Negative	Process	x		
UE061		x	Information handed over is available in a IT system other than the handover system.	Negative	Information	x		
UE062	x		Information handed over is available in a IT system other than the handover system and is accessed during the handover.	Negative	Information	x		
UE063	x	x	Information handed over is available on paper which is shown/given to one or multiple other participants of the handover.	Negative	Information	x		
UE064	x	x	Information handed over is available on paper notes written not by the person doing the handover.	Negative	Information	x		
UE065	x		Information handed over is available on paper notes written by the person doing the handover.	Negative	Information	x		
UE066		x	Information missing (Not available at handover) - Patients name.	Negative	Information	x		
UE067	x	x	Information missing (Not available at handover) - Other	Negative	Information	x	x	
UE068	x	x	Information missing. Person does not know information he/she is asked for. Neither in memory, notes nor handover system.	Negative	Information	x		
UE069	x	x	Information missing (Not available in handover system) - Single Patient	Negative	Information	x		
UE070	x	x	Information missing (Not available in handover system) - Group of Patients	Negative	Information	x		

Table D.5

List of usability events (page 5)

ID	Environ-ment		Usability Event	Assessment		Method(s) of discovery		
	1	2		Impact (perception)	Area	User Observation	Stakeholder Interviews	Heuristic Evaluation
UE071	x		Information missing due to unavailability of handover system.	Negative	Information	x		
UE072	x		Not enough information has been handed over for a particular patient.	Negative	Information	x	x	
UE073	x		Conflicting Information available.	Negative	Information	x		
UE074		x	Evidence of incorrect information (on system other than handover system).	Negative	Information	x		
UE075	x	x	Evidence of handover system (screen) not being used at all (Persona 1).	Negative	Process	x		
UE076	x	x	Evidence of handover system (screen) being only used as an auxiliary working surface (Persona 2).	Negative	Process	x		
UE077	x	x	Evidence of handover system (printout) being only used as an auxiliary working surface (Persona 2).	Positive	Process	x		
UE078	x	x	Evidence of handover system (screen) being used as primary working surface (Persona 3).	Positive	Process	x		
UE079	x		Evidence of limited possibilities to display graphic information.	Negative	Process	x		
UE080		x	Evidence of tension between departments and/or people involved in the handover.	Negative	Process	x		
UE081	x		Evidence that handover participant(s) do not concentrate on the handover and/or are distracted.	Negative	Process	x		
UE082	x		Person enters data into a system other than the handover system.	Negative	Process	x		
UE083	x	x	Person mentions video camera and/or any other device/person related to the handover observation.	Negative	Usability Method	x		
UE084	x		Person is distracted by the video camera and/or any other device/person related to the handover observation.	Negative	Usability Method	x		
UE085	x	x	Video observation started late and/or finished early.	Negative	Usability Method	x		
UE086	x		Activity / Person not visible in video	Negative	Usability Method	x		
UE087	x	x	The handover system allows for addition of free text data fields without code changes to the handover system or underlying database.	Positive	System			x
UE088	x	x	The handover system allows for addition of selection (i.e. drop down) data fields without code changes to the handover system or underlying database.	Positive	System			x

Table D.6

List of usability events (page 6)

ID	Environ-ment		Usability Event	Assessment		Method(s) of discovery		
	1	2		Impact (perception)	Area	User Observation	Stakeholder Interviews	Heuristic Evaluation
UE089	x	x	There is no line break functionality for the data fields. Hence, information that exceeds the column width is not visible in the user interface.	Negative	System			x
UE090	x	x	All the information in a particular data field is presented whenever the curser stays on the field for 3-4 seconds.	Positive	System			x
UE091	x	x	There is no line break in the data fields when all information is presented upon staying with the curser on the field for 3-4 seconds.	Negative	System			x
UE092	x	x	The handover system allows certain data fields (e.g. 'Anaesthetic' or 'Medical Hx') to be populated, even though there is no patient assigned to this row. Error message is displayed ('Please select patient first'), however data remains in data field.	Negative	System			x
UE093		x	The updated handover system has two columns with the header 'Warning'.	Negative	System			x
UE094	x	x	The handover system display a hourglass icon if a transaction is ongoing.	Positive	System			x
UE095	x	x	The menu for the handover system remains static and the user can access all the options from the same page.	Positive	System			x
UE096	x	x	The handover system makes use of colour (e.g. capacity status or Anaesthetic) but does not rely on solely on colour.	Positive	System			x
UE097	x	x	The handover system uses colour in an naturalistic way, e.g. red for warnings.	Positive	System			x
UE098		x	There is some alignment between data display on the handover system and IBAAAR proforma as outlined on the laminated card given to the handover participants (e.g. order of information and used terminology). However, there are also some discrepancies (e.g. Order: Planned Management and Anaesthetic / terminology: 'Past Obstetric History' vs. 'Obstetric Hx'.)	Neutral	System			x

Table D.7

List of usability events (page 7)

ID	Environment 1	Environment 2	Usability Event	Assessment: Impact (perception)	Assessment: Area	Method(s) of discovery: User Observation	Method(s) of discovery: Stakeholder Interviews	Method(s) of discovery: Heuristic Evaluation
UE099	x	x	The handover system presents information in a similar way than programs such a Microsoft excel. However, there are differences. For instance, only row but not columns can be marked. If the user clicks on the header of a column, it does not mark the column, but sorts it alphabetically.	Negative	System		x	x
UE100	x	x	The slidebar of the handover system does not resemble many other programs. For instance, the slidebars width does not resemble the visible pages width in relation to the overall with of the spreadsheet. Also, clicking on the empty space on either side of the slidebar does not move the visible are by a full page.	Negative	System			x
UE101	x	x	The menu of the handover system does not provide 'undo' and 'redo' options.	Negative	System		x	x
UE102	x	x	The handover system presents some of the information in the pre-populated data fields in an inconsistent way (e.g. 'age': '33y 5m' vs. '33yrs')	Negative	System			x
UE103	x	x	The handover system is inconsistent in regards to selecting medical staff: 'Midwife' is a editable free-text field while 'CaseManager' is a populated by choosing from a searchable list.	Negative	System			x
UE104	x	x	The handover system does not allow the user to edit standardised information such as 'Patient Name', 'NHI' or 'Age'.	Positive	System			x
UE105	x	x	At no stage during use of the handover system, the evaluator had to remember information from one screen that had to serve as an input into another screen.	Positive	System			x
UE106	x	x	Print view can be adjusted by administrator to meet users requirements.	Positive	System			x
UE107	x	x	The handover system allows users to change the width of each column.	Positive	System			x
UE108	x	x	The (user) adjusted width of the columns is reverted to the preset width each time the handover system synchronises data with the CMS database system.	Negative	System			x

Table D.8

List of usability events (page 8)

ID	Environment 1	Environment 2	Usability Event	Assessment: Impact (perception)	Assessment: Area	Method(s) of discovery: User Observation	Method(s) of discovery: Stakeholder Interviews	Method(s) of discovery: Heuristic Evaluation
UE109		x	Some of the columns have not been populated for any patient in the views observed on the handover system during the heuristic evaluation (system had been loaded with live data from the previous year).	Negative	System			x
UE110	x	x	The layout of the handover system menu bar is consistent for all users.	Positive	System			x
UE111		x	When exiting the 'bed manager' sub-application, the handover system presented a technical error message.	Negative	System			x
UE112		x	When choosing the 'Help Topics' menu option, an information window appears ('Will display the contents page of the help file'. Upon pressing 'OK', nothing happened.	Negative	System			x
UE113		x	When choosing the 'Tip of the day' (Help) menu option, a message 'did you know… That the \\CmsDbAcc1\CMS$\current\options\tip.txt file was not found?	Negative	System			x
UE114	x		Evidence of relaxed atmosphere at handover and/or people involved in the handover.	Positive	Process	x	x	
UE115	x		System does not display current patients and HDU patients on the same screen.	Negative	System		x	
UE116	x		Column 'nutrition' is superfluous and a duplication of column 'diet'.	Negative	System		x	
UE117	x		Handover system does not list pool rooms.	Negative	System		x	
UE118	x		Patient from WAU unit can be viewed.	Positive	System		x	
UE119	x		Column 'injury' is superfluous.	Negative	System		x	
UE120	x		Handover system does not display potential patients.	Negative	System		x	
UE121	x		Handover system does not present entered information in historical view.	Negative	System		x	
UE122	x		Lack of training has negative influence on handover process.	Negative	Process		x	
UE123	x		People are known to each other.	Positive	Process		x	
UE124	x		Process allows to pass the required information to other people.	Positive	Process		x	
UE125	x		Handover system does not allow for prioritisation of patients	Negative	System		x	
UE126	x		Handover system does display superfluous information (unspecified).	Negative	System		x	
UE127	x		Information not visible in the screen of the handover system (out of the screen)	Negative	System		x	

Appendix E: Presentation held at the 2011 HINZ Conference and Exhibition

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HINZ Conference and Exhibition 2011

A usability perspective on clinical handover improvement – CHIPS with everything?

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25 November 2011 / david.kaufmann1@gmail.com

Agenda

- **Introduction**
- **Setting (CHIP Project)**
- **Setting (CHIPS Study)**
- **Applied Methods (Framework)**
- **Applied Methods (Usability Evaluation Methods)**
- **Findings (Clinical Handover & System)**
- **Findings (Usability Evaluation Methods & Triangulation)**
- **Conclusion & Future Work**

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Setting
(CHIP Project)

- Handover at Women's Health Department at Auckland City Hospital.
- Current Handover Environment, Process & System to be improved based on Literature Review & Best Practice.
- Success of improvements (mainly data transfer) measured through two Evaluations, applying User Observation and Survey.

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Setting
(CHIP Project)

CHIP – Improvement of the Handover Environment

Before

After

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Setting
(CHIP Project)

CHIP – Improvement of the Handover Process

New overall proforma for handover

SHARING	
Staffing	Introductions/Update Board
High Risk	Handover delivery unit patients IBAAAR Handover HDU/DCCM/CVICU CCU patients with IBAAAR Handover antenatal/postnatal *patients of concern* with IBAAAR Expected Patients
Awaiting OT	Acute
Recovery/OT	Patients of concern
Inductions	IBAAAR
NICU	Open/Closed bed status
Gynae	IBAAAR

New proforma for handover of individual patient

IBAAAR	
Identification	Location name, NHI & age
Background	BMI, Parity, Gestation Past Obstetric History Medical Conditions, Meds
Alerts	Antibodies Allergies Social or CYFS issue Psychiatric issues
Analgesia	Type Anaesthetic concerns
Assessment	Reason for admission Relevant Bloods/Investigations Progress SROM/ARM Uterine Activity +/- Synto CTG Observations
Recommendations	Planned Management Next review Assessment Relevant teams informed

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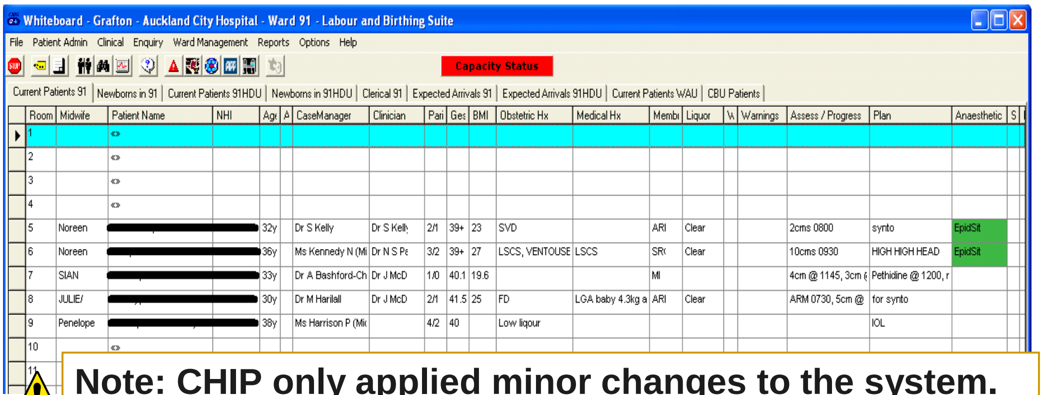
Setting
(CHIP Project)

CHIP – Improvement of the Handover System



Note: CHIP only applied minor changes to the system. (addition of columns, change of columns)

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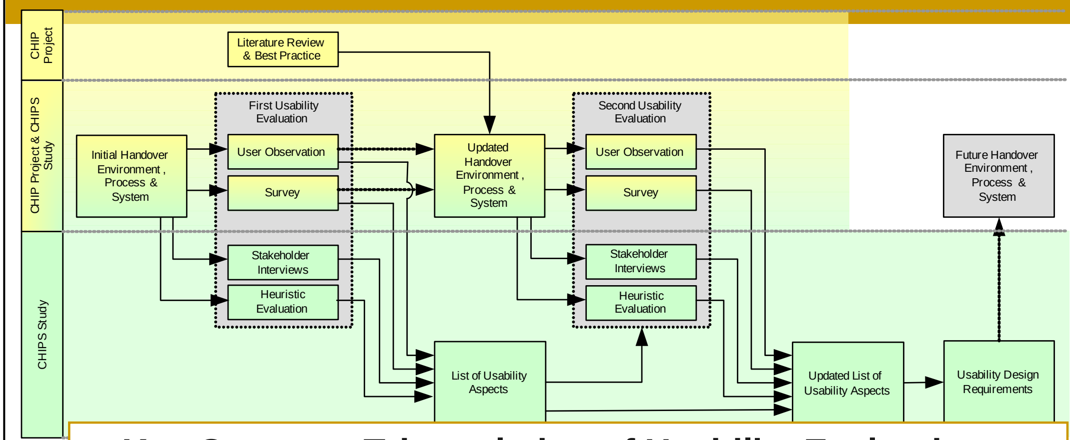
Setting
(CHIPS Study)

- Success of improvements measured through two Evaluations, applying four usability evaluation methods.
- Formulating Usability Design Requirements for future Clinical Handover System.
- Assess practical application of these Usability Evaluation Methods in a Health Care Setting.
- Assess practical application of the "Triangulation of Methods" concept.

Note: Study has not been completed yet.

Applied Methods
(Framework)



Key Concept: Triangulation of Usability Evaluation Methods as Each Usability Evaluation Methods has particular strengths and weaknesses. (Tan, Liu & Bishu, 2009)

Applied Methods
(Usability Evaluation Methods)

- **User Observation**

Application: Use of video recording / Observer took role of "onlooker".
Strength: Capture of actual user experience.

- **Survey**

Application: Use of Likert scale / 12 questions.
Strength: Simple data collection, anonymous.

- **Stakeholder Interviews**

Application: Use of voice recording / 11 questions (1 system specific).
Strength: Detailed stakeholder responses about specific problems.

- **Heuristic Evaluation**

Application: Based on Nielson & Mack's (1994) ten heuristic principles.
Strength: Finding usability issues that are hard to describe by the users.

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Findings
(Clinical Handover & System)

- **Handover Environment - Improvements**

Evidence: The number of observation logs in regards to negative environment related aspects decreased from 60 to 15.

- **Handover Process - Improvements**

Evidence: The survey showed that participants assessment of handover efficiency increased from 5.1 to 7.9 (means values on a scale from 1-10).

- **Handover System - Minor Improvements**

Finding: Due to the larger screen, the data is more visible. However, the system does still not store all the handed over data, is not aligned with the handover process and lacks of some best practice user interface design. For instance, it is not possible to enlarge the information for one particular patient.

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Findings
(Usability Evaluation Methods & Triangulation)

- **Methods: Medical domain knowledge is NOT required in order to discover a large number of usability aspects. In fact, domain knowledge could be unhelpful.**

- **Methods (Observation): Presence of Camera / Observer had only minor impact on participants.**

- **Triangulation of Methods: Empirical evidence that different methods highlight different usability related aspects. Triangulation allows for effective working in a "Real World" Environment.**

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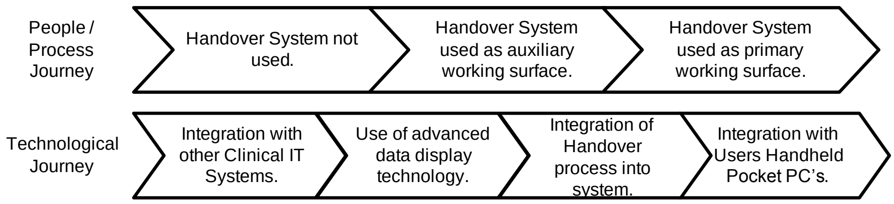
Conclusion & Future Work

- **IT Systems used for handover must further evolve, especially to address the issue of data loss.**
- **Usability assessment for Handover systems must acknowledge the handover process in order to meet key usability aspects of efficiency and user satisfaction.**
- **"Journey" to future Handover System.**



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Questions

Questions?

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Appendix F: Paper presented at the 2011 HINZ Conference and Exhibition

A Usability Perspective on Clinical Handover Improvement: CHIPS with Everything ?

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Abstract

Support for clinical handover remains a challenge for Health Informatics. Obstetric Handover is an important multi-disciplinary activity that can have important consequences for patient safety. Although IT systems can be used to support handover, the improvement of handover is not a purely IT-based problem. This project took place in the context of a clinical improvement process designed to formalise and improve handover in a busy delivery unit. This study used investigative tools from the usability domain in order to understand the usability requirements of a complete socio-technical system - the handover process. This work demonstrated the feasibility of using such tools and illustrated potential usability problems and solutions in the clinical handover process. Changes were made in IT systems, the organisation of the handover and the physical environment. Evaluation of the modified approach is being conducted, in the light of some usability issues already discovered. Usability evaluation tools appear useful and practical methods for assisting with clinical improvements in a complex and demanding area.

1. Introduction

Clinical handover remains a problematic area for quality improvement. The Clinical Handover Improvement Project (CHIP) was initiated at Auckland City Hospital (ACH) in order to improve this process, reduce the occurrence of adverse events and increase efficiency. The project includes a number of methods to identify and assess methods for clinical process improvement; An intervention based on the OSSIE guidelines [1], evaluation of the quality of information transfer via a questionnaire and video recording, pre and post intervention and usability assessments of the software and environment of use as part of the handover process.

1.1. Clinical Handover

According to the Australian Commission on Safety and Quality in Health Care [1], Clinical Handover is "the transfer of professional responsibility and accountability for some or all aspects of care for a patient or group of patients, to another person or professional group on a temporary or permanent basis." A professional group can consist of various clinical staff, such as midwives, nurses, doctors and/or allied health professionals.

Clinical Handover provides a significant risk for patient safety as it could potentially lead to adverse effects such as discontinuity of care or administration of the wrong medication. In the last 15 years many of the working schedules of Resident Medical Officers have changed. Shorter hours and a move to shift based rosters has resulted in increased numbers of doctors who are not so well known to each other and more Clinical Handover episodes during any given time-frame. These changes have the potential to increase the chance of Adverse Events occurring.

A survey conducted by McCann, McHardy & Child [2] at Auckland City Hospital found that 72 out of 73 medical practitioners had experienced at least one clinical problem due to poor clinical handover in the three months preceding the survey. As a result, much work has gone into the improvement of the clinical handover and among others, process improvements and utilisation of software has been suggested. In addition, because of the complexity and potential for serious error associated with clinical handover, any software-supported approach must have excellent usability.

1.2. Use of OSSIE guidelines

The OSSIE Guide to Clinical Handover Improvement [1] provide a set of empirical guidelines for the improvement of the clinical handover process. These guidelines emphasise clinical involvement and documentation of current issues in the process, in order to engage clinical staff.

1.3. Background to CHIPS

Handover continues to be a poorly performed process, in clinical care and research in this area is extremely active

Poor handover and the associated clinical risk to patients have been identified as an increasing problem throughout all specialities in medicine. There has been a great deal of literature generated on this topic in the past 5 years. The topic has been highlighted with the change in working hours of Resident medical officers (RMOs) and hence subsequent multiple shift changes reducing continuity of care and necessitating frequent handover of what can often be complex and extensive information. A recurring theme in the literature is the lack of appropriate "tools" for handover [3].

A number of working directives and subsequent guidelines have been generated to aid in standardising handover, including the SHARING pro forma established for the dynamic environment of the labour ward and associated units [4]. There are three main areas that are being addressed in the CHIPS project.

1.3.1. The Handover Environment

A 2010 study in neurocritical care by Lyons et al demonstrated that distractions affect information transfer and cause inefficiency [5].There are numerous studies supporting the use of standardised tools for handover. McCann et al showed that staff involved in handover highlighted the importance of a set location,standardised handover sheet and training related to handover [2]. While Jorm et al showed substantial improvement in the handover of outstanding jobs and overall patient data with the introduction of a standardised proforma [6]. Porteous et al have developed a clinical handover checklist which goes by the acronym iSoBAR (identify, situation, observations, background, agreed plan, read back) [7]. This, and other variants, has been incorporated into the OSSIE guide to clinical Handover Improvement generated by the Australian Commission on Safety and Quality in Healthcare [1].

1.3.2. Information Technology Support

The increasing use of electronic notes highlights the availability of potential methods to support information transfer. A survey by Hannan et al into the sustainability of medical morning handover showed a strongly positive result to the introduction of IT facilities to the morning handover meeting [8]. Studies also demonstrate that verbal handovers or verbal with note taking are less effective at complete information transfer and retention than printed hand outs with relevant patient information [9, 10].

1.4. Aim of this research

The study aims to produce a set of usability requirements, that extend beyond the user interface of the IT system that can be used for guiding future development of computer-supported handover. It is hoped that this work can identify successful approaches to improving clinical practice in the area of handover and also be useful in identifying appropriate methods for the evaluation of computer-assisted handover systems. This work uses some of the tools that are familiar (but not exclusive) to usability evaluators including observation, heuristics and requirements gathering approaches, in order to study a clinical activity that includes computer and non-computer based operations. Sociotechnical approaches [11] drive the overall process with the realisation that handover is a network process, that is collaborative and fluid , which must be investigated using empirical methods. As an illustration, consider that the clinical handover in this case can involve around 20 people and therefore 190 separate relationships between participants, some of which will not be mediated via the Computer system. Thus a solely Computer-centric analysis would never adequately appreciate the complexity of the domain and the interpersonal relationships involved.

We hope to show that this approach is in fact effective and simple in practice to both the researchers and clinical staff.

The overall study protocol and timeline is shown in Figure 1.

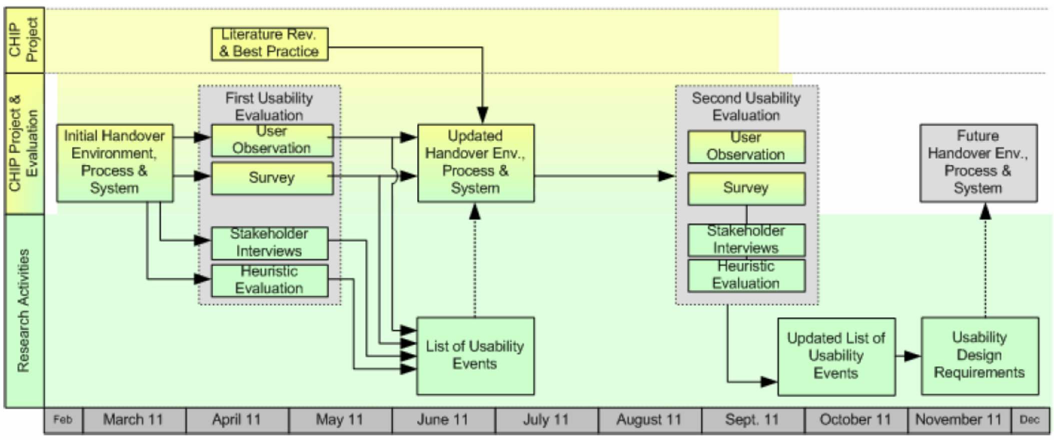

Figure 1 - Relationship between this research and the CHIPS implementation

1.5. Usability Evaluation / Observations

A large number of different usability evaluation methods have been used in the context of clinical information systems [12], giving a clear testimonial of the complexity and differences in view. Generally speaking, each evaluation method can be classified into one of two categories. On one side, there are "user based" approaches which, to some degree, all involve prospective users in the evaluation. On the other hand, there are "expert based" approaches which solely rely on usability experts and do not involve users. Despite the large number of proposed Usability Evaluations methods, practitioners seem to have a preference for a small number of them. Various contemporary papers (e.g.[13]) indicate that Heuristic evaluation and Usability testing are two of the most frequently applied methods, in both practice and research. Other sporadic but less frequent applied methods are Questionnaire, Interviewing and Cognitive walkthrough.

2. Materials and Methods

2.1. The CHIPS intervention

Two procedural approaches were modified from the OSSIE approach. SHARING (Figure 2) guides the Clinical Handover Process. This includes: Staff introductions, information about unit bed occupancy and clinical areas where information should be made available to the handover including outlying patients who might otherwise be omitted.

SHARING	
Staffing	Introductions/Update Board
High Risk	Handover delivery unit patients IBAAAR Handover HDU/DCCM/CVICU CCU patients with IBAAAR Handover antenatal/postnatal *patients of concern* with IBAAAR Expected Patients
Awaiting OT	Acute
Recovery/OT	Patients of concern
Inductions	IBAAAR
NICU	Open/Closed bed status
Gynae	IBAAAR

Figure 2 – SHARING: Protocol for running the handover

IBAAAR	
Identification	Location name, NHI & age
Background	BMI, Parity, Gestation Past Obstetric History Medical Conditions, Meds
Alerts	Antibodies Allergies Social or CYFS Issue Psychiatric Issues
Analgesia	Type Anaesthetic concerns
Assessment	Reason for admission Relevant Bloods/Investigations Progress SROM/ARM Uterine Activity +/- Synto CTG Observations
Recommendations	Planned Management Next review Assessment Relevant teams informed

Figure 3 – IBAAAR: Information about each patient

The second approach was IBAAAR (Figure 3). This is the information that should be handed over about each patient. These lists have also been printed onto a small laminated card, which can be attached to the ID lanyard, and have been issued to all clinical staff working in this area. In effect, SHARING, deals with who should speak, and IBAAAR deals with what they should say. These points were modified from previous approaches by the CHIPS steering group.

The aim of the intervention is to demonstrate an improvement in handover efficiency and effectiveness and hence reduce clinical risk.

2.1.1. Setting

The setting of the project was National Women's Health , Auckland City Hospital. The Doctors handover occurs at 08:00 and 22:00 on the labour ward. The handover is timetabled to take 30 minutes.

2.1.2. Participants

Many people are involved in the handover process. The minimum expected number of participants are four House Surgeons, four Obstetric and Gynaecology registrars (two from the outgoing shift and two from the incoming shift) and two specialists, In addition the Charge midwife of Delivery Unit, Clinical Midwife Associate (senior midwife available for the whole of Women's Health), one or two anaesthetists and the Charge theatre nurse. In addition obstetric physicians and private specialists may also need to be present and there are often medical students.

2.1.3. Software System

A "whiteboard" application (shown in Figure 4) is used to support the handover process. However this application obtains data from a patient management system and is not primarily designed to support workflow or handover. In many cases staff use printouts from this system to record handover information, by writing relevant information by hand on them. Major redesign of this system is currently not in scope for the project , but minor changes e.g. reordering of fields are possible.

2.2. Evaluation approaches

Multiple methods were used in the study and a triangulation approach was used in order to attempt to add rigour to the findings [14] .The chosen evaluation methods and their application used were; User observation, stakeholder interviews, a survey and heuristic evaluation. Note that, at this stage, a formal heuristic application has not yet been applied to the whiteboard software.

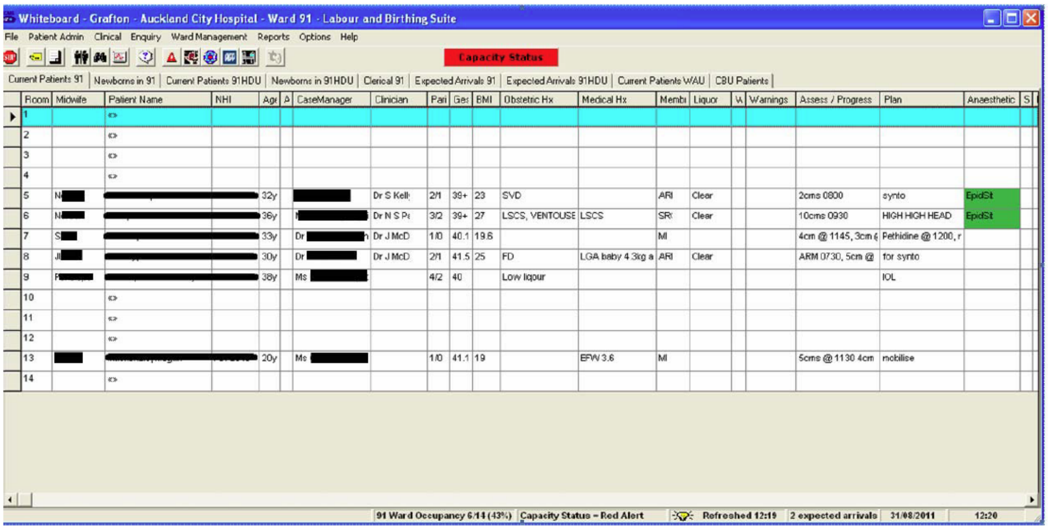

Figure 4 - The current software approach

2.2.1. Method 1 – User Observation

Ten user observations have been conducted in both the initial as well as the updated handover environment. The procedure was informed by Literature as well as three pilot observations. Due to the real world character of the environment and lack of subject specific knowledge (i.e. medical knowledge), the chosen evaluator role was the one of an "onlooker". This meant that there was no direct interaction with the participants during use (e.g. "Think aloud" technique). Due to the advantages of video recording, all observed handovers have been recorded on video. The recording of the handover also meant that the evaluator did not necessary had to attend in person. However, the handovers have been attended in person whenever possible as this allowed for the recording of additional observations that were outside the angle of the video camera (e.g. events that occurred on the screen of the handover system or reactions of participants in the background who were not visible on the video). The video recordings were analysed using a 17 point check list both pre and post change implementation.

2.2.2. Method 2 – Stakeholder Interviews

A set of stakeholder interviews has been conducted with various handover participants. The aim was to interview at least one role each . The questions asked at the interviews were the eleven questions suggested by the Australian Commission on Safety and Quality in Health Care [1, pg 2, section 1-3] for the "Organisational Leadership" phase of a handover improvement project. One additional question has been added which particularly referred to the patient spreadsheet of the initial/updated handover system. The need for the additional question has been realised after the pilot stakeholder interview as the eleven existing questions were not suitable to obtain specific information about the current handover system. For that purpose, a printout of the handover system spreadsheet has been taken to the stakeholder interview. Since interview participation was on a voluntary basis and off working time (see constraint 1), it was crucial to keep the interview duration in the range of 5-10 minutes. This has been achieved by the restriction to the 11+1 questions and by voice recording the interviews, which did not require the interviewer to take notes. Also, enquiries have been kept to a minimum and were only used in case where it was absolutely necessary in order to understand the given answer. The interview questions are shown in Figure 5 below.

Stakeholder Interview
Question
1.1) What is your definition of clinical handover?
1.2) What are the functions of clinical handover?
1.3) What do you think the transferring of responsibility and accountability during handover means?
2.1) Can you please discuss how handover is currently conducted in your department?
2.2) What do you think are the positive aspects of your current handover process?
2.3) What do you think are the negative aspects of your current handover process?
2.4) How do you think your current handover process could be improved?
2.5) What information do you require for continuity of patient care during your shift?
2.6) How could information technology help you with handover?
3.1) How did you learn how to do handover?
3.2) How do you think handover should be taught?
4) How could the current spreadsheet be improved?

Figure 5 - Stakeholder interview questions

2.2.3. Method 3 – Survey

A written survey was conducted by Dr Victoria Carlsen pre- and post-intervention (e.g. change of handover environment, process and system). The survey has been handed out to the participants immediately after the handover and consisted of thirteen question which addressed the areas "information transfer", "environment", "process" and "handover system". Participants could enter their answers by placing a cross on a 10cm visual analogue scale where the two ends of the scale represented the opposite answer possibilities (e.g. Always vs. Never). The survey questions are shown in Figure 6 below.

While the survey has been conducted by the CHIP programme and the questions have been tailored towards the aim of measuring the effectiveness of the applied changes, the collected data could still give valuable information in regards to usability and therefore assist in the process of identifying usability requirements. Ethical approval was obtained from the Northern Region ethical committee with code NTX/11/EXP/031.

Survey		
	Answer scale	
Question	From	To
1) Are Delivery Unit/WA handovers run effectively?	Very Effective	Not Effective
2) Is all essential information on patients handed over?	Always	Never
3) Is patient safety compromised by the current handover process?	Uncompromised	Compromised
4) During handover do you know the other members of the team?	Always	Never
5) Is the current environment where handover takes place, the DU workroom, appropriate?	Inappropriate	Appropriate
6) Would changing the environment help improve the handover process?	Helpful	Not Helpful
7) Is the current electronic whiteboard useful for handover?	Not Useful	Very Useful
8) Is the data on the electronic whiteboard relevant to handover?	Relevant	Not Relevant
9) Do doctors currently handover in a systematic and organised manner?	Organised	Disorganised
10) Would a pro forma be useful for DU/WAU handovers?	Very useful	Not Useful
11) Are outliers appropriately handed over?	Always	Never
12) Who should attend handover?	No scale. List of eleven roles that could be circled.	
13) Please add any comments regarding handover if you wish.	No scale. Empty space for comments.	

Figure 6 - Survey questions

3. Results

As the second part of the study had not yet taken place at the time of submission, the main results at present are those extracted from the initial video observation. Data from both sets of observations will be available at the conference.

3.1. Pre-intervention observations

One of the main areas of observation was the identification of the "working surfaces" used by the participants. This refers to the sources of information used and the areas where information is recorded.

3.1.1. Working Surface (current)

A critical dimension of usability can be described briefly as the 'working surface'. The working surface is the medium (screen, whiteboard, paper) on which 'work' is done. Work is some processing of information and this may involve interaction between people. Visibility, accessibility and control all have significant impacts on the success of the process. The use of a small computer screen caused a number of 'work arounds' that made the process opaque and broke the integrity of the data.

There is extensive use of paper by various members of the handover – as a means of providing an aide-memoire for the issues concerning patients to be handed over. Printed patient lists from the current electronic whiteboard are used as a surface where additional notes can be added.

3.1.2. Working Surface (future)

It is doubted that a handover system can be the sole working surface. People need printouts and they will write notes on them. If the information is on a note sheet, then this becomes the working surface. If the working surface has to become the handover system, then it needs to be ensured that as much information is in there as possible.

3.1.3. Lack of information

In many cases, there is critical and non-critical information that is not available in the handover environment.

3.1.4. Missing information in Handover system.

Contact information and bed status are captured outside of the handover system on conventional whiteboards, and other specialised information – including information about "outliers" is not available via the whiteboard.

3.1.5. Lack of process & attendance

There is no formal process and the handover participants change from day to day.

3.1.6. Missing System Integration

There were numerous cases where people had to retrieve information from a computer other than the handover system.

3.1.7. Information Presentation

There were numerous cases where people had to point at the screen of the handover system. This indicates that the discussed information could not be highlighted. It became obvious that not all handover participants could read the information shown on the screen of the current handover system, which is displayed on a standard PC monitor.

3.1.8. Necessary disruptions

The nature of a hospital means that people need to leave the handover in order to attend an emergency. It needs to be addressed how such disruptions are handled.

3.1.9. Unnecessary disruptions

The current handover environment has many unnecessary disruptions (printer, other people in the office, phone calls etc.)

3.2. Usability requirements

Usability requirements are non-functional requirements of a software system, that identify what sort of user experience a system may provide . Lausen [15] Identifies a number of ways of representing such requirements, many of which are based on specific metrics. In our case we would be unlikely to choose extremely quantitative metrics, but see the usability requirements as a set of guidelines that include important heuristics that need to be observed and areas of potential poor usability identified.

4. Discussion

This study is not yet complete as the post- intervention work has not yet been undertaken. However an number of questions and requirements have been identified, and a number of actions have taken place as part of the intervention. The handover process has been moved to a dedicated room with a large computer screen available. The SHARED/IBAAAR protocol has been implemented and continuing clinical education is taking place in its use. The whiteboard software has been modified to provide a greater range of information that is required under IBAAAR. One important change has been to identify "outliers" by using additional fields to identify patients that "belong" to women's health when not located within the women's health clinical area.

It is common to find that projects do not follow a path that will allow formative usability studies to proceed in an textbook fashion [16] . In this work we have attempted to use a multidisciplinary approach and take approaches from the usability toolbox and other areas in order to identify problems and solutions to the usability of the handover process. This appears to have been successful, and this approach could be used in different areas.

From the viewpoint of the usability assessment groups, one important discovery has been the relatively small amount of domain knowledge that has been required in order to study this process. The usability finding from observation and the usability requirements appear to be easily comprehended by the clinical staff, and they have found this helpful.

Initial results appear to show that the CHIPS project is both popular with clinical staff and appears to be assisting in handover quality. Continuing use of non-IT based working surfaces is being encouraged, and systems should be able to support both paper-based and screen-based displays of data.

4.1. Future work

There is a need for software to support real-world workflow, and multiple views of clinical data may well need to be added to existing clinical software. There may be value in the use of personalised "to-do" lists being added to users mobile phones and the use of novel working surfaces including RFID-enabled patient labels attached to physical objects such as individual notebooks.

5. Acknowledgments

Thanks must go to the CHIPS team, the clinical staff of the Women's Health Department ACH and David Churchouse from the audio visual unit ACH.

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