Patient self-registration
Design of a digital tool for an emergency department

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Abstract

In this bachelor thesis, a prototype of a digital tool is designed, aimed at self-registering patient data in an emergency ward. Normally, patients not arriving by ambulance are treated in the order they enter the waiting room. Nurses performing the first examination—a triage—must ask the patient about their identity, previous medical history and similar questions, and enter this data into a new treatment case in the healthcare information system. It has been suggested that having the patient enter this data themselves would be beneficial, allowing nurses to concentrate on the medical issues.

After gathering and analyzing data from observations and from interviews with the staff at a Swedish hospital, a prototype of a digital tool was designed, where patients step-by-step could enter the required data in the waiting room, thus saving valuable time in the triage. Benefits for the patient include receiving feedback about the number of persons ahead in line. The prototype was received favorably by test persons and by the staff, indicating that it could work as a model for a product to be put into work use.

Keywords: emergency department, patient registration, design theory, waiting room, prototyping, user experience
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I Introduction

This thesis is written on behalf of Cambio Healthcare Systems, Linköping. In a pre-study focusing on the needs of the staff and possible improvements to be implemented by Cambio (Förstudie Emergency, 2016), it was suggested that a digital tool for patients’ self-registration at an emergency department might be beneficial for the productivity and quality of the medical services provided. The design of such a tool was offered as a suitable task for a bachelor thesis in cognitive science.

The case of the study was the emergency department at a hospital in southern Sweden. The hospital has around 350 beds, 2,000 employees, and an uptake of 140,000 people.

The self-registration should be the first step of producing a treatment case in the healthcare information system COSMIC, containing medical records and other functions. COSMIC is a comprehensive system for all types of healthcare, ranging from university hospitals to community nursing homes (Cambio Healthcare Systems, 2017).

1.1 Background

In a broad sense, this project deals with the meeting between patient and staff at emergency departments in hospitals. More specifically, the subject is the design of a digital tool with the potential of making this meeting more effective. Before going into the details of the project, a background description is provided.

1.1.1 Triage

When patients arrive at an emergency department in a hospital, their need for care must be evaluated. In an article by Andersson, Omberg & Svedlund (2006), the history and purpose of this process, known as triage, is described. Starting as a term for the sorting of wounded patients during World War I, it’s use has spread to public health care. Ever since, triage has become an indispensable part of the emergency treatment system.

Usually, the triage is performed by nurses, with the goal of prioritizing and ranking non-urgent patients. The decision reached is based on several factors: all the symptoms and problems the patient is experiencing, but also general condition
and medical history. Patient with life-threatening conditions are obviously taken care of immediately.

The staff performing the triage need three basic proficiencies: quick judgement based on evidence at hand; comprehensive knowledge in the field of injuries and pathological presentations; intuition based on long-time experience. They also need to manage stress well, to cooperate with the physician, and to relate to the patient’s needs, physically as well as psychologically.

1.1.2 The time factor

The time factor is important when performing the triage. The emergency department can be a very busy workplace, where time is scarce. To make correct judgement under these conditions requires excellent skills (Andersson et al., 2006). The starting point of this project is the notion that if some part of the triage process can be shortened by making it more efficient and focused on the medical issues, this is potentially of great value.

As for the physical examination, this must obviously be made during the actual meeting between staff and patient. This part of the assessment usually contains a more or less standardized set of questions (Andersson et al., 2006). The communication needs to be structured and systematic when the nurse asks the patient or relatives about diseases and symptoms or problems. Again, shortening the time needed for collecting some basic information concerning such as the non-acute patient’s identity, symptoms, and medical history could be valuable.

Time is an important factor also in the questions the nurse asks the patient. Long-term symptoms usually mean that a patient safely can be less prioritized, while those with for instance acute pain need fast attention (Andersson et al., 2006).

1.1.3 Using the waiting time

Usually for patients arriving to the emergency department without obvious life-threatening conditions, a period of waiting is facing them. If not properly informed about the reasons for having to wait, this can be frustrating as well as painful. For the patient, the waiting room experience plays an important part in how satisfying the hospital visit is perceived (Sherwin, McKeown, Evans, & Bhattacharyya, 2013).

In a Swedish study, patients were asked to evaluate their experience of a stay in an emergency ward (Sabirova Höjerström, 2013). Overall, the patients were satisfied, but the waiting was viewed as frustrating due to lack of information. All means of letting the patients know more about for example how many patients are waiting before them could be valuable.

If the waiting period, at least to some extent, can be used for purposeful activities, frustration might decrease (Sherwin et al., 2013). Most waiting rooms are equipped with children’s books, magazines, folders, and perhaps some toys. Sherwin and his colleagues also suggest some more active forms of interventions: validated questionnaires; question prompt sheet or coaching; patient education material; decision aids; and a waiting room manager (WRM) helping to implement the other
interventions. These suggestions are meant mainly for primary care facilities, but can serve as an inspiration also for the emergency ward. The authors claim that time spent in the waiting room to screen, monitor, and educate could enhance the patient’s overall experience, resulting in increased patient satisfaction. This is correlated to greater adherence to medications, increased mental and physical functioning, and higher self-reported quality of life (Mosen, et al., 2007).

As medical care becomes more and more digital, the possibility of letting the patient be active in the data gathering is obvious. For this purpose, comprehensive systems for self-diagnosis such as CLEOS (Clinical Expert Operating System) are being developed (Zakim, Alscher, Schwab, Schwalm, & Sundberg, 2014). This system does not (yet) cover all diagnoses, but stores more than 28 thousand possible data fields. Sitting by a computer, patients are asked a large number of questions. Based on previous answers, the patient is step by step given a differential diagnosis. When finished, the system makes a final diagnosis and presents relevant data and suggested treatment to the physician. Evaluations of the system indicates that it can find more problems than physicians do on their own. Patients found the method as a serious attempt to raise the quality of the care. Using a tablet computer for answering was positively evaluated, even by computer novices. (Zakim et al., 2014)

In CLEOS, the average patient spends about an hour filling in 385 data fields, which would not be suitable in an emergency department (Zakim et al., 2014). Using non-digital forms, a similar idea is used in “Lättakuten”, a Swedish “light emergency department” at a primary health care center (Karlsson & Larsson, 2014). Patients choose a suitable form, fill it in and hand it over to a nurse. The nurse registers the patient in the electronic medical record (EMR), administers the laboratory tests that are needed, and gathers all the collected data in a stack of papers. Finally, when the treating physician meets the patient, this data serves as a quick overview of the situation, making the examination more effective for both parties. The physician completes filling in the form, prescribe medication and give instructions to the patient. The completed form in eventually scanned into the EMR system. (Karlsson & Larsson, 2014)

The effects of this method of managing the visits was rated positive by patients as well as by the staff (Karlsson & Larsson, 2014). The patients felt safe and well treated. The physicians stated that they could focus more on diagnosing and treating when background data was provided in a standardized way. The productivity was also greatly increased compared to traditional acute-time booking concept. A possible extension of this method would be to let the patient enter some of the required data—e.g. personal information and symptoms—directly in digital form.
1.2 Research questions

The philosophy of making the patient an active party, as described by Sherwin et al. (2013), could be put into use also in a regular emergency department. This can be achieved by the use of a digital tool—a simplified electronic form for self-registration—to be filled out by patients while entering the waiting room.

Potentially, the use of such a tool could increase the time available for the actual assessment during the triage. It could also give the nurse performing the triage a quick summary of the patient to be evaluated, thus aiding the very first decision concerning prioritization.

The aim of this study is to investigate if patient registration could be more efficient using a digital form for self-registration, to be filled out by patients in the waiting room.

The research questions are thus:

- How is patient registration managed today at the emergency department of the studied hospital?
- In what ways can this be improved?
- How could a digital tool be designed to collect information directly from the non-acute patient?
2 Behavioral studies

When working with human–computer interaction, the primary concern is finding technical solutions to user needs. This points to the need for semi-structured qualitative methods, where understanding needs and practices are of paramount importance. (Blandford, 2017)

The following chapter describes the used methods and procedures, from the initial observations to the final product. During the first and second phase—data collection and data analysis—qualitative methods were used. This provided the knowledge needed for the third phase—design—in which a prototype was developed.

2.1 Data collection methods

To learn about the domain and clarify the goal of the project, two methods were used: observation and interviews with members of the staff at the studied hospital. The purpose of such research is to obtain an understanding of the problem area to get inspiration and information for the design work (Arvola, 2014).

In order to find a suitable case for the study, an email was sent to several hospitals among the customers of Cambio Healthcare Systems. Some of these replied that they were interested in the subject of possibly enhancing the patient admittance process, but unable to participate due to lack of time.

After receiving positive response from one hospital, a two-day visit was arranged. The members of the staff were all highly cooperative, seemingly intrigued by the project.

2.1.1 Observation

To get a deeper understanding of a situation, first-hand observation is fundamental. This way, discrepancies between written and oral statements concerning an activity and what actually is taking place can be noted by the observer (Howitt, 2010).

In the field of cultural anthropology, participant observation is almost universally viewed as “the central and defining method of research”. (DeWalt & DeWalt, 2002) It has a history reaching back to the 19th century, and has been used in countless studies.
The core of the method is, according to DeWalt & DeWalt (2002), not simply observing and recording the behavior of others, but to actively take part in the events taking place. This way, a deeper understanding can be reached. The goal is to reach a tacit knowledge, possible only if the researcher has a personal, perhaps even emotional, experience of the situation.

DeWalt & DeWalt (2002) further describe how participation can be performed at different levels of involvement. In this study, moderate observation was used. Two days were spent at an emergency department, where the researcher was doing the observation openly, but not actively taking part in the events, and with restricted social interaction.

2.1.1.1 Participants
The researcher observed nurses and secretaries at work, by themselves or interacting with patients. The researcher wore hospital clothes and a badge, showing her status as a student, sitting in the background during the nurse–patient encounters. Ethical aspects were considered by using a written description of: the background and the aim of the project; method; risks; benefits of participation; data storage and confidentiality; voluntariness and responsibility. After reading, participants signed a consent form.

2.1.1.2 Procedure
The observations were made using a semi-structured method. A basic set of questions to ask and points to observe was prepared, and subsequently used during the two days on site. Semi-structured observations have clear, yet open goals, allowing issues to emerge from the observation (Gillham, 2008). This type of observation is, according to Gillham, suitable for identifying practical problems experienced by people in a given context, and how they can be resolved.

The first day of observation lasted for approximately seven hours in the afternoon and evening, and was mainly spent with the medical secretaries. Some of the interactions between the researcher and staff were made while they were working in the reception, some in the adjoining paus area. One of the secretaries gave a guided tour of the waiting room, reception area and emergency room. The interior was documented in form of a sketched map, along with notes about the premises and the actions that took place.

During the observation, the researcher used jotting as a method of gathering data. Jottings are brief written records of the events taking place, usually by using key words and phrases (Emerson, Fretz, & Shaw, 2011). They might also include personal impressions of the situation. The jotting resulted in a large amount of raw data, including photographs of the physical setup and equipment, and handmade sketches depicting the layout of the department and some of the computer software being used.

When needed, the secretaries were asked to clarify and explain the situation. The emergency room was mostly calm, with few patients in the waiting room at a time. This allowed for rich conversations with the secretaries, discussing their work and the present as well as past patient registration process.
The second day of observation started at eight in the morning and lasted for approximately eight hours. Some initial observations were made by merely walking around the hospital floor, taking notes and asking questions about the conducted work. The researcher followed the nurses around and watched them interact with patients. In total, about ten nurses were observed, three of these were followed more extensively.

Some patients arrived with ambulances, while most patients came through the waiting room. During triage, the researcher sat or stood in the background, observing how the nurses went about their examinations and registered information about the patients in COSMIC.

In the evenings following these initial recording sessions, the jottings were summarized into structured field notes. These should ideally be straightforward, giving a neutral description of what had taken place (Emerson et al., 2011). All in all, the field notes consisted of ten A4 pages with text and images (photographs and sketches).

2.1.2 Interview

To gain understanding about the hospital domain, qualitative, or semi-structured, interviews were conducted with stakeholders and staff. This method is characterized by the interviewer designing questions that encourage the interviewee to talk freely and extensively about the studied topics (Goodwin, 2009). Although time consuming, qualitative interviews can, according to Goodwin, generate rich and extensive data. In such an interview, the interviewee does most of the talking, while the interviewer steers the direction of the conversation and probes for more information.

Unlike structured interviews, the interviewer does not follow a strict list of questions, but rather uses pre-defined questions as a guide and allows the conversation to progress in a natural way, following up on the answers provided by the interviewee (Howitt, 2010). Howitt further states that the goal is to ask open questions that allow the interviewee to give elaborate answers.

Cohen & Crabtree (2006) describe that once observations have been made where the researcher has been able to develop an understanding of the topic of interest, this method is well suited for developing relevant and meaningful research questions. They summarize the benefits of semi-structured interviews to include the researcher being prepared and appearing competent during the interview; allowing interviewees the freedom to express themselves in their own terms; and that the interviews can provide reliable, comparable qualitative data.

2.1.2.1 Participants

Four interviews were conducted, all of them in a private room at the hospital, during the two days of observations. The first interviewee—also being the primary stakeholder—was the physician in charge of the department. This interview lasted for approximately 25 minutes. Three nurses were interviewed for about 10 minutes each, one of them being a line charge nurse.
The interviewees were recruited on site, all of them volunteering after being presented the same information as previously mentioned regarding the ethical aspects of the study. All interviews were recorded with permission from the interviewees. The recordings can only be accessed by the researcher, and they were treated anonymously.

2.1.2.2 Procedure
The following questions were used as a guide for the semi-structured interviews:

- Could you describe the process from when a patient arrives to the emergency room to when they see the medical staff?
- Are there any difficulties or annoyances in this process?
- Is there anything that makes the process stop?
- What takes the longest time in the process?
- How would you like for things to work?
- Could the patient somehow be more involved?
- What is the most important function of the waiting room?
- Is there anything else you would like to talk about?

The interviews were transcribed in order to make analysis possible. In total, the four interviews were transcribed into 13 A4 pages.

2.2 Data analysis methods

In qualitative research, the data needs to be analyzed using non-statistical methods. A large number of methods are described in the literature, but giving the one being used in a specific a clear etiquette is a challenge: “Because of the shortage of names for qualitative research methods, there is a temptation to call a study an ‘ethnography’ or a ‘Grounded Theory’ […] whether or not they have the hallmarks of those methods as presented in the literature.” (Blandford, 2017)

If falling for this temptation, the present study could be described as using a simple form of grounded theory. As being discussed later, every design process needs to be “grounded” in the sense that one needs to be deeply familiar with the situation at hand. Also, the researcher/designer usually does not have a preconceived theory/solution regarding the situation. The analysis should ideally be “the interplay between researchers and the data” (Strauss & Corbin, 1998).

The data from the observations and interviews were analyzed using thematic analysis. Howitt (2010) describes this as a relatively straightforward form of qualitative analysis which requires the researcher to identify a limited number of themes to describe what is happening in textual data. This sort of thematic analysis is a descriptive method which tends to generate research findings which are easily grasped by the general public (Howitt, 2010).
It is important that the researcher has intimate knowledge of the data, preferably achieved by collecting the data oneself, transcribing, reading and re-reading the data several times (Strauss & Corbin, 1998). The researchers need to become familiar with the material to the level of “letting the data speak to them”. In this study, this was done using printed field notes and interview transcriptions.

In the following step, the researcher coded the data by giving brief descriptions to small chunks of data: the topics of the answers given or observations made. For each new topic discovered, a code was written in the margin of the page. In the words of Strauss & Corbin (1998), this is a sort of microscopic analysis.

In the next step, the codes were categorized into the broader themes. This involves “asking questions” to the material, trying to grasp what the codes are expressing, as well as making comparisons between the codes (Strauss & Corbin, 1998). Is the interviewee talking about problems or solutions? Is he or she talking about specific times or places, or about the roles and tasks of the people involved? What seems to be most important, resulting in strong terms of description? The discovered themes are presented and exemplified with codes and quotes in 2.3.2.

### 2.3 Results

The results of the behavioral studies consist of two parts. Firstly, the patient registration process is described, followed by the themes derived from thematical analysis of the gathered data.

#### 2.3.1 Patient registration

Some years ago, the patient registration was made by the secretaries. Patients would sit in a small enclosed area, being interviewed. The problem with this method was that it was hard to draw a line between registration and performing a sort of triage. Since this is beyond the responsibility and training of the secretaries, the decision was made to have nurses do the registration during triage.

Today, patients who arrive at the emergency room at the studied hospital are instructed to take a queue number, and wait in the waiting room until they are called by a nurse. During observations, it was found that many patients miss the instructional sign and ask the secretaries for instructions. Secretaries reported that they answer many routine questions per day and were frustrated by this.

Nurses see patients sequentially, and call out for the next patient in line from the waiting area, inviting them in to one of the triage rooms. One, or preferably two nurses, examine the patient and asks a series of routine questions. These questions consist of:

- Asking for identification.
- If the patient has a referral.
- If the patient has had contact with other health facilities.
- If the patient has been treated abroad in the past six months.
- If the patient wants total confidentiality.
- The reason for coming to the emergency department.
The nurse creates a new treatment case in the digital medical record system, and fills in the given information. This process takes a few minutes for each patient, sometimes more, depending on the nurse’s speed in navigating the system.

After examining and interviewing the patient, the nurse assigns the patient to the relevant specialty in the emergency department (surgery, medicine, orthopedics, infection).

For acute patients arriving by ambulance, the procedure is somewhat different. The first part of the registration is made in advance after receiving information from the ambulance staff. The identity is double checked when the patient arrives. A physician is present in the room together with nurses. As the physician performs the examination and possible acute treatments, a nurse registers relevant information into the medical record system. Some examination data given by the physician is recorded on paper, later to be digitally registered.

Non-acute patients arriving by ambulance undergo the same triage and registration process as patients arriving through the waiting room, in a room adjacent to the ambulance entrance.

2.3.2 Thematic analysis
In this section, each identified theme is presented in reverse order of how they were derived from the data: name of theme; codes; quotes. The quotes are not attributed to a specific person or professional category. This was not considered relevant for the analysis, given the unanimity of the expressed opinions.

Theme 1: Process and technology of current patient registration
- time and effort consuming
- especially for non-experienced nurses
- taking time and focus from actual care
- many clicks
- many minutes of writing per work shift

“I think the problem is that it takes too much time from the actual patient work. Since we have a limited number of people performing triage, it always takes a few extra minutes to fill in. There’s a lot of clicking, and that’s just a small part of the actual care work.”

“Well, it takes a lot of time. There are so, so many click all the time.”

“When working a whole day in the triage, you spend a lot of time on registering patients. […] I think I’m rather fast since I’ve grown up using computers, but I know that it takes quite some time for some of my colleagues to register patients.”

“Registration is annoying, both that it takes time to actually fill in the information, and if you’re alone with a patient you have to work and write simultaneously. You want to get the patient into the system as quickly as possible, and it requires many clicks before you even get the patient into the system.”

Theme 2: Process and technology of future solution
- using tablets instead of queue numbers
• patients registering in the waiting room
• self-registration creating a new treatment case in COSMIC
• comparing to registration at the dentist’s office
• a system to check identification; treatment case already in the computer when seeing a new patient
• patient fills in personal identity number and reason for visit
• patient fills in confidentiality, referral, having been to another care facility, having been treated abroad
• patients would have to prioritize worst symptom
• must be easy for patients to register
• integrating the chest pain button from the queue number device
• the secretaries could help patients unable to fill out the form
• patients would not be able to choose division of emergency department
• patient confidentiality is crucial

“Couldn’t the patient itself create the treatment case?”

“[…] Self registration. Some sort of system that can create a treatment case […], and we’d just call in the patient and already have a treatment case. Then we’d have to assign it to the right division, or if it’s just a normal nurse visit, but it would still be faster than registration today.”

“It can’t be too complicated either, so that it’s difficult for the patient. It should be really simple for the patient – write your personal identity number, have you seen a doctor already, what are your symptoms. It wouldn’t need to be much more than that.”

“Perhaps fill in personal identity number, have you been at the primary health care center? What are your symptoms, and then you’d have some categories to choose from: I have chest pain or I have a fever or I have trouble breathing, I’ve injured my foot. It wouldn’t have to be much more. Do you have a referral? It feels so simple somehow – it should be able to work, but I don’t know.”

**Theme 3: Prioritization in the waiting room**

• patients are dissatisfied with sequence in the waiting room
• secretaries check on the patients
• sequence is difficult
• some patients take advantage of chest pain button as a short cut into triage
• patients frustrated over waiting time
• patients can tell secretaries if their condition is getting worse
• not possible to prioritize in the waiting room
• patients are seen in a sequential order

“If you walk through the doors, you take a queue number, and from there we see them sequentially, completely without prioritization. Or there is one distinction and that’s if you have chest pain you’re supposed to press a particular button, and then you’re treated immediately.”

“Prioritization in the waiting room is really difficult. We have no idea what their symptoms are, so we bring in whoever has the next queue number. Then you can
have someone who sits out there and is really ill, and instead you bring in someone who sprained their ankle two days ago. In that way prioritization can be a little off in the waiting room, but we can’t really do it any differently.”

**Theme 4: Functions of waiting room**
- buffer zone before triage
- assembly point
- patients show they want help
- a nurse checks on patients during high load
- many patients don’t understand the queue number system
- queue number device is translated into Arabic
- many patients with referral are unsure what to do in the waiting room

“Once a person has entered the waiting room and taken a queue number we can assume that they want our help.”

“Really, it’s just a buffer zone for us as our resources in the triage aren’t infinite, on the contrary, it’s very limited.”

“Many patients incorrectly choose the chest pain button, often because they don’t understand the language and just click on the red button”.

**Theme 5: Role of the secretaries**
- must stay on top of the flow of patients
- tired of answering routine questions
- informing family members about patients
- giving patients and family members access to emergency department
- monitoring the waiting room

“We have secretaries who are not trained in medicine, who sit there doing other work, but should anyone feel really bad or in some other way need immediate attention, the person has the possibility to [through the secretaries] pass on the message to medically trained staff.”

“I feel like we say the same thing a thousand times per day.”
3 Design

Human–computer interaction (HCI) is, according to Arvola (2014), to a large degree dependent on the interface. He further states that the potential of the interaction in terms of effectiveness, benefits, work environment and many other aspects is thus a result of the interface design.

The third research question of this study deals with the design of a digital tool. As a foundation for the actual design of a product, a theoretical discussion is needed. What is design, and how does it relate to humans interacting with computer based tools? Some of the relevant aspects of these issues are summarized in this chapter, along with descriptions of the design leading up to a suggested solution in the form of a prototype.

The design process of the project had four primary phases:

1. Establishing the requirements using personas, scenarios, and storyboards.
2. Defining and mapping goals.
3. Producing sketches and prototypes.
4. Evaluating the prototypes.

As described below, this was far from a linear, or even an iterative process. Rather, it was a more or less continuous movement between the phases.

3.1 The design process

As a verb, design is “the craft of visualizing concrete situations that serve human needs and goals within certain constraints” (Goodwin, 2009). Design is purpose-driven, striving to make something useful out of restricted means. Stolterman (1991) writes that design is “to invent, choose, form and determine the functions, appearance, possibilities and limitations of a something”. He further states that a design process always involves actively and consciously creating, assessing and choosing. Every design is unique; if you are simply following a “recipe” it is a case of production, according to Stolterman (1991).

Nevertheless, a design method needs to be rational and possible to explain. This rationality must be based on a solid understanding of the situation. Understanding is by its nature personal, containing what Stolterman calls conceptions
("föreställningar") and thought figures ("tankefigurer"). The conceptions are abstract constructions describing the overall situation. They are to a large degree transferred from the design area, for instance from a certain design education. The thought figures are more practical tools, based on knowledge in the fields of reason, aesthetics, and ethics. An example could be architects learning styles and techniques from their predecessors.

Based on these concepts, Stolterman describes the design process using this model:

1. The process takes off with a specific design situation, and starts in the instant that the designer starts working with it.
2. The designer then crosses the border between the concrete and the abstract “thinking” (the dashed line) and starts looking among his or her ideals and thought figures.
3. Based on the fluctuation between the specific situation and the ideal/thought figures (the upper left bidirectional arrow), a vision starts forming in the mind of the designer.
4. This vision in its turn affects how the designer perceive the situation (the upper right bidirectional arrow).
5. Bit by bit, the designer creates an operative image.
6. The designer develops the operative image, making it a more and more stable point of departure for the work to follow. This is achieved using a dialectic process between the design situation and the operative image (the lower left bidirectional arrow), as well as between the vision and the operative image (the lower right bidirectional arrow). This affects the designer’s view of the specific design situation.
7. After this, a more structured design process follows, where testing and evaluations are taking place. Finally, this leads to making a product. This too involves a design process, often leading to revisions of the operative image.

The central part of Stolterman’s description is the dynamic nature of the design process. In his view, the first overall design actually takes place simultaneously—
or even before—any closer analysis of the design situation. At that stage, the problems to solve are hard to define. Rather, they appear as a result of the comparison between the vision and the operative image on the one hand, and the design situation on the other. In a sense, the problems are “created”, or designed, simultaneously and in the same way as the solutions are designed and eventually chosen. (Stolterman, 1991)

To summarize, the design process is not linear, or even iterative; Stolterman calls is “a completely dynamic process”, where all parts of the process are connected in a “total mutual influencing”. You cannot make this process work if you try to force it into being linear, Stolterman argues. Also, the actual problems to be solved cannot be clearly defined until the designer have started the design work.

Arvola (2014) describes design as a process involving planning, thinking and creating based on the conducted research. The effects of a design are difficult to predict and communicate. Therefore, design is usually illustrated through prototypes and sketches, enabling the designer to compare the design’s effects in certain situations.

3.2 Human centered design

The successful user interface needs to be human-centered (Arvola, 2014). This fact is central also to the international standard, where human-centered design is defined as an iterative process (ISO 9241-210, 2010), involving the user’s point of view, the development of a deep understanding of the users, and utilizing different skills. The standard describes five stages of the design process: planning; understanding the situation; specifying the user needs; producing a result; evaluating the result. The evaluation can result in the process starting over.

The design in this study follows these steps closely, based primarily on the needs of the staff wanting a more efficient method for patient registration.

The focus on human needs must take into consideration that our perception is heavily biased by at least three factors (Johnson, 2014):

- The past: our experience
- The present: the current context
- The future: our goals

The setting of the current study—an emergency department—is in many ways extreme. People coming there are often highly stressed because of an illness or injury, and have as an immediate goal to be assisted by a medical professional. They may or may not have previous experience from this situation. The proposed design must accommodate this, making the tool easy to grasp and meaningful for the patient, while meeting the requirements put on it by the staff.

3.3 Interaction design and human–computer interaction

This project focuses on a certain type of design, namely interaction design. This discipline deals with form and behavior of products, services, and systems
Interaction design affects the intrinsic functionality of a product, not simply “what it looks like”, which is a common interpretation of design as such. It deals with issues such as what activities a product or service support; what workflow to use; information management in the process; how the product is subdivided and how users move between the parts (Goodwin, 2009).

Closely related, but distinct from interaction design, is the field of human–computer interaction (HCI). Here, the usability as such is in focus, along with quality assurance. The two fields are thus complementary: does the designed product (interaction design) work in an efficient and understandable way (HCI)? (Goodwin, 2009)

The ideals of HCI need to be materialized in the practical design of software. This is described in more detail in 3.5.

3.4 Goal-Directed Design

The designer always has a goal in mind; in a broad sense, to help solve problems for humans by creating a useful artefact or service. In this project, the goal of the design was limited and clear: to create a digital tool—a web form—that will collect basic data from patients visiting an emergency department.

The approach taken is an example of Goal-Directed Design¹, described in (Goodwin, 2009). This method consists of four components: principles, patterns, process, and practices.

- **Principles**—closely related to what Stolterman calls conceptions—are the basic guidelines for good design, e.g. that in most cases, an undo command is useful.

- **Patterns** are the building blocks of the design, which can be described as the words constructing a sentence. (Using this simile, the principles are the grammar for the language.) This is similar to Stolterman’s idea of thought figures: the designer’s collected experience of solutions that work, and solutions that don’t.

- **Process**, in this model, is described in a linear fashion: Project Planning > Research > Modeling > Requirements Definition > Framework Definition > Detailed Design > Implementation Support. In this chain, modeling is a form of data analysis, using personas and other methods to describe typical behavior patterns and goals. The actual design takes place during framework definition and detailed design. This linear model is very different from Stolterman’s view of a constant fluctuation between these aspects of the design.

- **Practices** deals with people and resource management within the design team as well as outside of it.

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¹ Goal-Directed Design® is a registered trademark of Cooper (www.cooper.com).
3.5 Principles, patterns, and affordances

The capabilities of digital tools have evolved tremendously during the history of information technology. Along with it, interaction designers have been given more and more possibilities to create useful and user-friendly software and other services.

As a basis for this, a number of design principles have been established. Some of these are at a very basic level, stating for instance that good design is ethical, purposeful, pragmatic, and elegant (Goodwin, 2009). More practical principles state that the solutions should put as little cognitive pressure on the user as possible; it should strive to be visual rather than text based; provide necessary but not redundant information; should be as consistent as possible; and so on (Goodwin, 2009).

These principles form the foundation of good design. In order to be efficient for the designer as well as for the potential user, the finished product normally should consist of as many well-known patterns as possible (Tidwell, 2011). Tidwell describes that, as information technology has matured, many patterns have evolved, making interaction design more of a laying a puzzle than a making a painting. Familiar patterns are for example dual or triple panes showing different levels of detail; hierarchical menus; parallel workspaces; controls such as checkboxes, radio buttons and choice drop-down lists. All in all, this palette of patterns makes up what Stolterman (1991) calls “thought figures”, helping the designer to concentrate on the more important issues at hand.

In order to further help the user to understand what to do, the concept of affordances has come to play an important role. This was introduced by Norman (1988) as a term for describing design that invites and motivates the user to perform an action, and to show what types of actions are available and which ones are not (Arvola, 2014). A colored button invites pressing; a grey button indicates that a specific function for some reason is unavailable.

A well-designed user interface thus contains familiar patterns and affordances, intuitively guiding the user forward in the process, providing good feedback (Kaptelinin, 2017). If several complex steps are needed, “breadcrumbs”, arrows, percentage counters or other means of indicating process can give cues on how much is left for the user to do before finishing.

3.5.1 Prototype design

The users of the tool to be designed, being patients in more or less acute need of assistance, should be presented with an interface that is self-explanatory, and easy to follow in every step of the way.

With this in mind, several considerations are to be taken, despite the relatively simple tasks expected by the product (Wickens, Hollands, Banbury, & Parasuraman, 2013). The examples referred to in the bullet list below are shown in screen shots of the finished prototype in 3.10.5.
• First, the attention of the user needs to be directed to the right place as soon as possible in the “general orientation and scene scanning” that takes place during the first glimpse of something. *Example:* To help patients with chest pains past the entire process of self-registration: their needs are immediate, and cannot wait even the few minutes it takes to fill out the digital form. For these patients, a large button is needed, sending a distress signal to the staff. Other affordances include letting the “Next” button change color, once the required information is given.

• Another important design principle was that of spatial proximity. *Example:* Every page on the digital form should contain only one type of information, and choice buttons should be clearly grouped under a large heading.

• The textual information needed must be as short and clear as possible, using everyday language as far as possible. *Example:* Considering the multicultural setting, the tool should be provided in Swedish, English, and Arabic.

• The users are under obvious stress arriving to the emergency ward, probably lowering the attention span. The working memory of the user should therefore be put into work as little as possible. Having to remember information that was given previously should be avoided.

• The selection of action—what to do next—should be evident throughout the process.

• The need for multitasking or switching between tasks should be avoided.

### 3.5.2 Gestalt principles

Johnson (2014) describes several “Gestalt principles of visual perception”: a descriptive framework for rules that can help a designer to make successful products. Some of these were used in the prototypes produced in this study:

• **Proximity:** the questions and the Yes/No-buttons in step three as placed in distinct rows.

• **Similarity:** in step four, the fields for filling in name and phone number have similar appearance.

• **Continuity:** the progress bar on the top of all steps shows how they are linked.

The prototype was given a simple and symmetrical layout. Perceiving structure helps humans to make sense of objects and events quickly (Johnson, 2014). In step four of the prototype, this is shown by balancing the buttons to the left with a large text control to the right. The goal here was to show that the patient first should choose a category, then describe symptoms by writing something. This sort of visual hierarchy is also important in order to guide the user (Johnson, 2014).
The use of colors can also help the user (Johnson, 2014). In the prototype, the light grey choice buttons turn darker blue when clicked; the light grey “Next” button turns red once all mandatory information is given.

Aesthetically, the choice was to design the prototype in accordance with the corporate identity of the county council (landsting). Usually, this consists of a combination of graphical profiling and value statements, and is used by all sorts of organizations to make a visual statement about itself and to communicate its philosophy. (Corporate identity, 2017) In this case, the corporate identity sets colors, logotype and text fonts of the prototype.

Following these guidelines, two subsequent prototypes were developed; the second being based on the evaluation of the first.

3.6 Personas and scenarios

Personas were created to better understand what the data means and make better design decisions (Goodwin, 2009). A persona is, according to Arvola (2014), an archetype that describes observed behavior patterns and goals of the potential users and customers. It is a tool to help increase empathy in the design, created by compiling all the data collected through observations and interviews, presenting them in the form of a character which comes to life through a name, picture and personality. It is a synthesis of the data from several participants and becomes a tangible impersonation of the needs and goals that the design is for. The personas are further brought to life through scenarios which describe hypothetical situations where the persona uses the designed product. (Arvola, 2014)

Using personas, needs from all of the interested parties can be identified. Direct users are of course central, but all other stakeholders can be put into personas. (Goodwin, 2009)

In this study, two personas were used: a nurse and a patient. The first of these was based on the interviews and observations in this study; the second was based on a study performed by Sabirova Höjerström (2013), where the patients’ experience of two Swedish emergency departments were investigated. With these personas in mind, three scenarios were developed.
Lena Nilsson

**AGE** 37

**OCCUPATION** Emergency room nurse

**EXPERIENCE** 14 years

“It would be great if patients had already registered when I see them. That way I could focus on actually seeing and caring for the patient. Patient registration takes such a long time and is very frustrating”

**MOTIVATIONS**
- Caring for patients
- Providing the best possible treatment in an efficient way
- Working together with colleagues

**FRUSTRATIONS**
- Spending too much time on administrative work
- Having to start each patient meeting with the registration process
- Not knowing if an ambulance or waiting room patient is more urgent

**NEEDS**
- More rational and efficient flow of patients
- Having patients already registered in Cosmic when she sees them in triage
- More time to spend on treating patients
SCENARIO 1

Mona (patient) is at home, making lunch when she cuts her finger. The wound is deep so she immediately grabs some tissue and tries to seal the gap. She picks up her phone and types “cut deep” into a search engine, and reads an article at 1177.se. If the wound is deep enough, one is instructed to seek emergency health care. She wraps more paper around the finger and takes the bus to the hospital. When she arrives, she walks in trough the emergency doors. She sees a sign that reads “register here” and walks up to the monitor. She types in her personal identity number, using the keyboard. She answers questions about her condition and confidentiality. She reads information about the screen about the number of patients in line, and is directed to go sit down in the waiting area.

SCENARIO 2

Lena (nurse) is working in the triage with her colleague Jon. They have just finished with a patient and are ready for the next one. Lena asks Jon to go bring in the next patient from the waiting room. Not knowing who they’re going to meet next, Jon calls out the queue number for the next patient. Once inside the triage room, the two nurses introduce themselves and Jon asks for the patient’s identification, which he gives to Lena. Lena creates a new treatment case in COSMIC and starts entering the patient’s personal information. While Jon is preparing the examination of the patient, Lena asks the patient a series of routine questions about
previous contact with health care facilities, confidentiality and so on. She enters the information into the treatment case.

**SCENARIO 3**

When Mona (patient) arrives at the hospital, she notices a sign that reads “Registration” and walks up to it. She finds out that the computer screen in front of her is for self-registration and sits down to use it. She reads the instructions and follows the steps of the registration process. When she has finished, she receives feedback from the system about her queue number, how many patients are ahead of her in line and some practical information. She sits down in the waiting area, knowing that it is almost her turn. When the nurse Jon calls her to the triage room, she enters and sits down on the bed. Nurse Lena asks for Mona’s identification and confirms that her personal identity number corresponds with the information in the treatment case which has already been created in COSMIC through Mona’s self-registration. Both nurses carry out the examination of Mona’s condition.

### 3.7 Storyboards

A way of illustrating the persona’s actions is by turning the written scenarios into storyboards (Arvola, 2014). Arvola describes a storyboard as a powerful tool for conveying a vision and mediate emotion. By showing both the current situation and possible future solution in the form of for instance a comic strip, stake holders and others can better understand the designer and gear towards a common goal.

The images below show the storyboards developed in this study. They were produced using a software called Pixton, developed for making comic strips, but well suited for illustrating all sorts of events.

---

**Figure 2:** Storyboard depicting a scenario where a patient arrives to the emergency department, as it is today.
Figure 3: Storyboard depicting patient registration as it is today.
3.8 Requirements

Based on the analysis of background data—in this case resulting in personas, scenarios, and storyboards—the requirements of the product can be expressed (Goodwin, 2009). This is an intricate part of the process, not to be confused with simply describing wanted features or technical solutions, perhaps inspired by other, similar products or services. Ideally, requirements should not be concrete specifications of the solution. Instead, they should be described in terms of “high-level needs that help project stakeholders make business decisions” (Goodwin, 2009).

However, since one of the requirements focuses on digital data, this implies that the technical solution must be based on the use of some sort of computer. The options most discussed with the stakeholder were tablets being lent out to the patients to be used in the waiting area, and stationary computers with touch screen, possibly equipped with a keyboard. The option of having the patients download a mobile phone app, or use a web service with their phone, was quickly ruled out, since all patients can’t be expected to bring such a device.

The suggested solution could work well on a tablet as well as on a stationary setup. Apart from the risk of theft and accidents, a stationary computer for public use is more robust. The hardware also needs to be easy to clean or disinfect in order to keep it free of contagious substances. Having to administer the loan of tablets would also be an unwanted task for the secretaries.
So, what are the functional requirements of the solution? Typically, requirements aim at describing what data is involved in the designed process, what users should and could do with the data, the qualities of the solution, and the constraints that surrounds it (Goodwin, 2009).

Based on the original proposition from Cambio, the thematic analysis of the interviews, on personas, scenarios and storyboards, the following requirements were defined.

First of all, patients should be able to enter data that generates a treatment case in COSMIC. This has potentially many effects, positive and potentially negative. The staff are freed from a routine task, giving more time to the medical issues. It also makes it possible to have a continuous overview of the group of patients waiting to be met: how many, who are they, why are they here, are there special considerations to make?

The data entered by the patient should include the following:

- Identity.
- If the patient has a referral.
- If the patient has had contact with other health facilities.
- If the patient has been treated abroad in the past six months.
- If the patient wants total confidentiality.
- The reason for coming to the emergency department.

A possible addition would be to ask if the patient has any blood illness. This was discussed during the interviews, but ruled out since it might be considered too sensitive. One other important requirement—stressed repeatedly by the staff during interviews—is to make the tool as quick and easy to use as possible. This is a strong argument for keeping the number of questions at a minimum, only including the most relevant and frequently asked questions during registration today.

Another requirement is to make the registration tool available in several languages. Today, the queue number device is supplemented with an instructional sign in Arabic to meet the needs of many non-Swedish speaking patients. During observations and interviews it was also discovered that many patients during the summer are tourists from various countries. Therefore, the registration tool should be available in Swedish, Arabic and English.

Furthermore, privacy while using the registration tool is of uttermost importance. Patients should be able to provide the necessary information in a private place, where no one is able to see what is being filled in.

3.9 Effect goal mapping

In the design process, the goals of the finished product gradually become clearer. By continuously asking why something is a problem, the goals emerge out of the fuzzy start (Arvola, 2014). Some of these goals are strictly technical; others are
more focused on the user experience and even emotional response. Such “usage quality” is, according to Arvola (2014) an important aspect of the design.

To manage a set of desired outcomes, an effect goal map can be a useful tool (Arvola, 2014). Using the map, the identified goals are connected to the interested parties of the issue at hand. These actors can contribute to the common effect goals once their own goals have been fulfilled.

In the present study, the actors were identified as being Manager, Nurse, Secretary, and Patient. The goals of the first three of these were derived from the thematic analysis of the interviews. The goals of the patients were found in the work of Savuriva Höjerström (2013). The overarching effect goals were presented under the heading Self registration. (See Figure 5)

![Effect goal map of the study.](image)

**3.10 Prototyping and evaluation**

The operative image, as described by Stolterman (1991), is often made in the form of a prototype: a term derived from Greek “first form”. A prototype is a sketch showing how a future product or service can be formed, in its entirety or in parts
As Arvola and Stolterman point out, the prototype also plays an important role in clarifying the problems at hand. It is simply more or less impossible to define all issues before you have something to look at and start testing.

Prototypes can be more or less advanced and detailed. Within interaction design, sketched paper-based prototypes are described as LoFi (Low fidelity), while interactive computer-based prototypes are called HiFi (High fidelity) (Goodwin, 2009). Some prototypes mix the two varieties, showing parts in greater detail (Arvola, 2014). HiFi prototypes are useful for testing complex interaction, such as entering different kinds of data. For users, however, it can be frustrating if the prototype is not complete in every detail. (Goodwin, 2009)

The prototypes designed in this study have several goals, as described in the effect goal map. All of these fall under the category of usage quality, as described by Arvola (2014). In order to fulfill the goals, the tool for self-registration need to adhere to the principles described earlier, using familiar patterns and affordances.

The prototypes produced in this study are of the HiFi type, using the Axure software. This enables a faithful representation of a working computer application, although not actually producing an output. Before a prototype can move to the next step—being iterated or put into the production phase—it needs to be evaluated by potential users. Arvola (2014) points out that testing can provide insight into issues such as:

- How the user moves through the prototype.
- Success rate (does not solve the task; solves it with difficulty; solves it easily).
- Situations in which the user gets into trouble.
- Behaviors showing that the user does not understand the interface.

Evaluation of design can be made in several ways, such as focus groups, expert reviews, and usability testing (Goodwin, 2009). Which method or methods to use depends on the project timeline, budget, and objectives. For evaluating functions and usability, Goodwin recommends the latter two. In the current study, having potential users test the prototype was considered the only viable choice. This was complemented by a standardized questionnaire given to the same group of users.

### 3.10.1 Think aloud test

A valuable method for collecting user opinions is to let the user test a design and its usability while orally describing what they are doing. This think-aloud method gives the designer a clear picture of how users maneuver through the steps of the tested solution (Lewis & Riemann, 2017). Of special interest are confusions and problems users encounter, or if several users make the same mistake (Arvola, 2014). These difficulties may not seem relevant for the user, but can provide essential information for the designer, comparing the designers’ mental models with the users.
A think-aloud test may also include discussions with the user initiated by the designer, covering interesting aspects, overall impressions, and suggestions for improvement (Arvola, 2014).

In this study, the participants were asked to think aloud as they navigated the system. The test started with the participants receiving the following instructions orally:

“You have had a stomach ache for several days. Today it got worse so you called 1177 for guidance. They advised you to immediately go to the emergency room for an examination. When you get to the emergency room, you walk through the entry doors and see a sign that reads ‘Register here’. By the sign is a computer screen with touch control, and a keyboard. You sit down by the computer and read on the screen”.

The participants were first asked about their first impression about the system and were asked to describe the parts of the interface they could see, and the actions they thought possible. After that, they followed the steps of the registration process while they described what they were doing. The researcher did not answer any questions about the design during the tests. Notes about the participants’ interaction with the system were taken by the researcher. Audio was recorded with permission from the participants. After finishing the registration process in the prototype, the participants were asked the following questions:

- What was your overall impression of the system?
- What did you like about the system?
- What did you not like about the system?
- Is there anything missing?
- Could you describe the design briefly?
- Do you think most people would be able to use this system?

The answers given were written down by the researcher.

3.10.2 SUS survey

All the participants in the think-aloud test were given a standardized questionnaire in the form of a System Usability Scale (SUS). This is a tool for measuring usability, created as a part of the usability engineering program in integrated office systems development at Digital Equipment Co. Ltd, Reading, UK (Brooke, 1996). The goals were to design a cost efficient and simple way of evaluating the usability of systems within an industrial context.

SUS has become widely used in industry. Benefits of the method include (System Usability Scale (SUS), 2017):

- It is an easy scale to administer to participants.
- It can be used on small sample sizes with reliable results.
- It is valid, and can effectively differentiate between usable and unusable systems.
Brooke (1996) gives detailed instructions for designing a SUS questionnaire. It should consist of ten statements about the system’s perceived usability. The statements are alternately positive and negative.

The respondent should give his or her opinions without too much hesitation, immediately after finishing the usability test. The statements are rated on a Likert scale of five, from “Strongly disagree” to “Strongly agree”, given numeric values of 1 to 5.

To calculate the SUS score of a test, the answers are first summed. For the positive statements (1, 3, 5, 7, and 9), score contribution is the scale position minus 1. For the negative statements (2, 4, 6, 8, and 10), the contribution is 5 minus the scale position. The sum of the scores is then multiplied by 2.5 to obtain the overall SUS value. This can range from 0–100, indicating the system’s usability ranging. A score of 100 would then be a perfect result. (Brooke, 1996)

According to Sauro (2011), based on data from over 5,000 individual SUS responses from 446 studies, the mean score is 68, with a standard deviation of 12.5. Thus, any SUS score higher than 68 can be considered to indicate better than average usability.

3.10.3 Prototype 1

The work with Prototype 1 started with sketching on paper. In these sketches, rough outlines were produced and refined. The example below shows one of the many sketches produced, which includes several of the functions to appear in the prototype.

![Figure 6: Sketch showing components of the coming prototype.](image)

The first HiFi prototype was then produced in Axure, based on the desired patterns described. This way, a realistic model of the required functions was built.
3.10.4 Evaluation of Prototype 1

The first prototype was evaluated with five students from Linköping University: 2 male and 3 female, with an average age of 25. A tablet computer (Microsoft Surface Pro 3) was used during the tests, which took place in a café at the Linköping University campus. The participants were given the same information and consent form as previously mentioned (see Appendix 7.1). The details of the procedure are described in 3.10.1 and 3.10.2.

The following table shows a summary of the users’ comments during think aloud tests and subsequent interviews. A plus sign indicates positive comments, and a minus sign indicates the opposite.

<table>
<thead>
<tr>
<th>About the design</th>
<th>About interaction</th>
<th>Interaction problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Clear</td>
<td>+ Logical sequence of steps</td>
<td>- Tries to press enter to get to next page</td>
</tr>
<tr>
<td>+ Minimalistic in a good way</td>
<td>+ Good amount of information /page</td>
<td>- Does not understand which format to use for personal number</td>
</tr>
<tr>
<td>+ Trustworthy</td>
<td>+ Distinct</td>
<td>- Unsure how much to write in symptom text field</td>
</tr>
<tr>
<td>+ Nice looking</td>
<td>+ Easy to use</td>
<td>- Unsure if one has to print queue ticket</td>
</tr>
<tr>
<td>+ Nice</td>
<td>+ Easy to understand</td>
<td>- Unsure what happens when you press ”KLAR” (done) on last page</td>
</tr>
<tr>
<td>+ Adequate</td>
<td>+ No difficult choices</td>
<td>- Wishes that input of personal number would be more clear (for instance by showing correct format statically)</td>
</tr>
<tr>
<td>+ Not too busy</td>
<td>+ Simple</td>
<td>- Wants further explanations of terms such as “sekretess” (confidentiality)</td>
</tr>
<tr>
<td>+ Welcoming</td>
<td>+ Good to see which step one’s at</td>
<td>- Unsure if all questions about previous medical contacts are mandatory</td>
</tr>
<tr>
<td>+ Clear colors</td>
<td>+ Clear what you can/cannot do</td>
<td>- One user presses chest pain button as it felt “close enough” to stomach pain</td>
</tr>
<tr>
<td>+ Good that important words are bold</td>
<td>+ Good to see number of pages</td>
<td></td>
</tr>
<tr>
<td>- Missing headings on each page</td>
<td>+ Clear feedback</td>
<td></td>
</tr>
<tr>
<td>- Does not understand what speech bubble on first page represents, is it clickable?</td>
<td>+ Likes that next-buttons changes color (affordance)</td>
<td></td>
</tr>
<tr>
<td>- Marker of active page in progress bar may not be clear enough</td>
<td>+ Questions feel complete</td>
<td></td>
</tr>
</tbody>
</table>

Functions
- Likes SMS function
- Likes that one can enter relative’s contact information
- Likes that contact information of relative is optional
- Likes that one is able to choose multiple symptom categories
- Likes information about number of patients in line
- Thinks symptom categories are too extensive
- Would like a clock in the header
- Don’t like that one receives queue number after pressing chest pain button
- Suggests quick menu for more acute symptoms, rather than just chest pain button
- Does not understand why there is a question about confidentiality
- Confidentiality feels unnecessary
- Wants examples of why one’s visit would be confidential
- Thinks some people would type too much about symptoms in text field

- Thinks buttons for printing queue ticket and registering phone number are already selected

**Device**
- No need to use a mouse
- Feels like a touch interface
- Touch feels natural due to large buttons
- One user chooses to use touch pad instead of touch screen

After performing the think aloud-test, each participant filled out a SUS survey. The SUS score mean was 95 with a standard deviation of 3.5. This high value can at least partly be explained by the simplicity of the task. The amount of data input required is small, and the steps to be taken are rather few. The first attempt was thus rather successful, but improvements could still be made.

### 3.10.5 Prototype 2

The second prototype is shown in its entirety below. Compared to Prototype 1, graphical fine-tuning was made. The progress bar was somewhat enlarged; all steps were given headings and icons; the language tabs were simplified; some components were re-arranged and lined up in a more consistent way.

An added function was to simulate an on-line connection to the Swedish population registration, making it possible to have name and address filled in automatically once the personal identity number was submitted. Another new function was the choice of receiving a text message when there are less than three people ahead in line.

![Figure 7: The start screen. To the left, a button stating “PRESS HERE” if you experience a chest pain, since this might indicate a heart ailment needing immediate care.](image-url)
Figure 8: Step two: Personal data. User is asked to fill out personal identity number or select 'I don’t have a Swedish personal identity number'.

Figure 9: User has entered personal identity number. When filled in correctly, this is validated with a check mark. Name and address are automatically displayed, derived from the Swedish population registration.
Figure 10: Step three: Previous contact with care givers. User is presented with questions about having a referral, having had previous contact with the primary health care, and having being treated abroad during the last 6 months.

Figure 11: User has selected the buttons representing his/her answers.
Figure 12: Step four: Confidentiality. User is asked about confidentiality and given the option to fill in contact information of a relative.

Figure 13: User has answered the question and entered contact information of a relative.
Figure 14: Step five: Reason for visit. User is asked to choose one or more symptom categories and briefly describe their symptoms.

Figure 15: User has selected a category and described the symptoms.
Figure 16: Step six. User receives feedback about queue number and number of patients ahead in line. User can choose to print a queue number, activate a text message notification when their turn was coming up, or press 'finished'.

Figure 17: User has chosen to print a queue number.
Figure 18: User has chosen to activate the text message notification function.

Figure 19: User has entered a valid phone number, which is validated with a check mark. The confirmation states that a text message will be sent when there are less than three people ahead in line.
3.10.6 Evaluation of prototype 2

The evaluation of Prototype 1 proved to be so positive that further evaluation could be limited to a workshop with stakeholder and staff. This took place on site, with the researcher, five hospital employees and one Cambio representative. After a detailed presentation of the work process and all its ingredients, the researcher demonstrated the prototype. The prototype was received favorably in terms of functionality as well as layout and graphical design.

Figure 20: First page of presentation held during evaluation workshop

After a series of questions both to and from the researcher, followed by a creative discussion, a number of constructive suggestions were agreed upon. The following changes should be made to the prototype in a third iteration:

- Add symptoms of stroke to the acute “shortcut” that today only covers chest pain.
- If the user checks the box “I do not have a Swedish personal identity number”, he/she should be instructed to exit the software and go to the reception. Secretaries will register those patients manually as a new temporary number must be generated.
- Help text on the start screen: Do you need help? The secretaries can help you register.
- If there should be such a function as the text message notification, it would have to send a message when there are 7-8 patients ahead in line.
- ”Describe you symptoms” may be too vague and should be reformulated.
- At the page ”Sökorsak”, patients should only write their symptoms in more detail if they choose the category “Annat” (Other).
• Change the name "Vårdcentral" to “Hälsocentral”.
• Change the category “Sårskada” (wound) to “Skada” (injury).
• Shorten question about referral to “Har du remiss?” and add the possibility of reading an explanation of the word.
• Add a question asking if the patient approves of the staff reading medical records from previous occasions through NPÖ (Nationella patient-översikten).
• Patients should be able to edit their contact information. Allowing them to add a phone number would be beneficial for the staff, especially with patients from other parts of the country.

Other topics discussed were practical matters such as where to place the computers for registration. One option would be to remove the chairs adjacent to the triage rooms and replace them with stations for registration. All seating would then be in another part of the waiting area. This way, secretaries would have an overview of the registration area from the reception and could easily assist patients when necessary. At least one of the computer screens would need to be accessible for patients in a wheelchair.

Some concerns about implementation were raised. How would contact information about relatives be registered in COSMIC? This sort of data is not stored in the treatment case and would need to be updated in the patient’s file. Should new information overwrite old information or be an addition to what may already be there?

Lastly, the issue of prioritization which was raised in pre-study interviews was elaborated upon further. There are pros and cons of allowing nurses to see patients’ symptoms before meeting them. This is discussed further in section 4.
4 Discussion

An important delimitation of this project is that the prototype designed has not been tested using a functional product. The effects it can have on patient behavior and satisfaction, staff tasks and effectiveness, and of the quality of the work at the emergency department can only be discussed on a hypothetical level.

Participants for the evaluation of the first prototype were selected through a convenience sample. This led to a homogenous group of university students, all under the age of 30 and experienced users of technology such as that of the tested prototype. This is likely to have affected the result of the evaluation, which would benefit from being tested with a wider range of users. One goal of the design is that it should be accessible for all patients who are well enough to be able to fill out a form themselves. With that in mind, testing with a wide range of users would have been preferable. However, users stated during testing that the system was easy to use, intuitive and familiar to similar services. The test results indicate that the proposed tool should be easy to learn for most people.

If the tool is as easy to use as the evaluation suggests, then having it put into a working product is likely to raise patient satisfaction, as discussed by Sherwin, McKeown, Evans, & Bhattacharyya (2013). Getting the chance of immediately describing their symptoms and history, getting feedback on the line in front of them, and possibly having a text message sent to them if they leave the waiting room, would likely increase the feeling of assuredness that their needs will be taken care of. For some, this might be sufficient; for others, a personal contact with the staff would be preferable.

A potential argument against a digital registration tool, is that patients may prefer actual human contact by registering with the secretaries. However, as previously discussed, this is not considered a tenable solution by the hospital staff. The digital tool should be an improvement to the current solution of merely taking a queue number, without receiving any further information. By submitting some personal information and the reason of one’s visit, patients may get a sense of being seen, which was one of the needs found in Sabirova Högerström’s study (2013). As the system also provides some feedback about waiting time, patient satisfaction should
improve. However, it is important to place the registration computers in such a way that the medical secretaries get an overview of the registration area from the reception. Should patients struggle or have any questions regarding registration, secretaries should be near to assist the patients.

It also seems likely that a working system like the one suggested would decrease the time needed for nurses to make the patient registration. In turn, this would potentially free time for the medical aspects; performing a triage rather than being an administrator. This could decrease the stress and increase the quality of the triage. The nurse will have a better chance of being the highly competent professional needed, as described by Andersson, Omberg & Svedlund (2006).

One prospect of the project is that the role of the secretaries will change slightly. Instead of having to answer questions about how to register—informing patients that they’re only supposed to take a queue number and wait for the nurse—they would, with the new system, if needed assist patients with self-registration. One could argue that a similar problem will occur, and that secretaries will be constantly pointing to the registration computers. This is difficult to avoid altogether, due to some patients’ high stress levels while in the emergency room. With proper and clear displays, indicating where and how to register, this problem should however be kept at a minimum.

One methodological constraint was the fact that no end users—the patients—were interviewed during the concept phase of the design work. In human centered design, users’ needs are the main focus of the process. Basing all patient data on another study (Sabirova Höjerström, 2013) is not optimal, yet the most convenient solution for this study. Patients in an emergency department are likely to be stressed due to illness or injury, therefore contacting them would have to be done after their hospital visit. This would entail getting access to patients’ personal information, which impose ethical and practical issues too far-reaching for a project in the scale of this study. The ethical aspects of working with patients is apparent in all studies in the field of medicine. In this study, this was avoided by focusing on the views of the staff as the aim of the project is primarily to meet the needs of the staff in their daily work. The patient’s viewpoint is, however, central for the subsequent design work and evaluation.

One subject that was discussed with stakeholders and staff during the pre-study interviews and evaluation workshop was the possibility of nurses using the output from patients’ self-registrations to prioritize in which order to treat patients. This is a complex question with no easy answer; one of the more common statements during interviews was “prioritization is very difficult”. On one hand, it seems reasonable to treat the most severely ill or injured patients first. This is not possible today as nurses have no idea what type of patients are in the waiting room. With a digital tool for self-registration, however, nurses could be able to see the symptoms that patients have reported. One nurse stated that it would be nice to be able to see what kind of patients are in the waiting room, much like they receive information from ambulance staff about the condition about patients arriving with an ambulance. That way, nurses would be able to decide if a patient in the waiting room
room or ambulance is more urgent. However, all symptoms reported by the patients are subjective assessments of one’s own condition, and could not be compared to a nurse’s judgement during an actual triage. Therefore, it appears that the current “first in, first out” system that is used today is the best option.

During the evaluation workshop, it was discussed whether or not staff should at all be able to see patients’ reported symptoms before the first physical meeting. One argument is that each nurse-patient meeting should be a blank slate. It is important that the nurse sees the patient without preconceptions, in order to create a genuine, fresh encounter with each patient. On the other hand, there is one practical benefit of knowing about the patients’ condition before seeing them: to identify the patients that are not supposed to be at the emergency department in the first place. Patients seeking for eye problems, dental problems, or patients that simply aren’t ill enough are referred to another care facility, without being admitted to the emergency department. By seeing these patients as quickly as possible, the queue could diminish, allowing for more efficient treatment of the patients that are to be emitted.

4.1 Further suggestions

If a tool for self-registration was implemented, the effects would need to be evaluated. The discussion hints at some possible positive and negative outcomes that might be taken into consideration.

The suggested design also inspires to further development. As described in the introduction, time spent in waiting rooms can be used in several ways for the quality of the care and for patients’ overall experience.

During interviews, and during the meeting with the staff when Prototype 2 was presented, some additional ideas were produced:

- Could the tool re-direct patients coming to the emergency department when their need can only be met by e.g. an ophthalmologist?
- Could the system generate temporary number for patients that do not have a Swedish personal identity number?
- All patients arriving by ambulance are in fact not in acute need of care. Could one terminal be placed by the ambulance entrance, allowing patients that are well enough to perform the self-registration?
- Could the ambulance staff make the registration, at arrival or in the ambulance?
- Could patients coming with a referral have this automatically connected to the treatment case?

Other ideas of improvement deal with adding features to the patient self-registration tools:
• Should it be possible to access the tool also through a web service, using a smartphone? If so, should it be made possible to start registering while on the way to the hospital?

• Could the identity of the patient be checked using a digital id such as BankID?

• Once the self-registration process is complete, the tool could lead the patient on to further information, e.g. describing how the work in the emergency department is staffed and organized, or lead to educational medical information, possibly based on the answers given.
5 Conclusions

This study posed three questions:

- How is patient registration managed today at the emergency department of the studied hospital?
- In what ways can this be improved?
- How could a digital tool be designed to collect information directly from the non-acute patient?

The results indicate that the staff at the emergency department was not satisfied with the manual process used today, where the examining nurse needs to spend time on registering basic data instead of focusing entirely on the medical aspects.

Having the patient do at least part of this themselves while waiting for their turn seemed an obvious way of solving this problem. In that sense, the initial assumption from Cambio was proven correct.

The prototype developed shows one possible design of a digital tool for patient’s self-registration. Based on positive evaluations and comments from test persons and from staff, it seems likely that this the prototype might work as a model for a product to be put into work. The prototype was described as easy to use, with a design well adapted to the hospital setting. It would register the basic information needed for the nurse to start the triage, making this more effective, fully taking the advantage of the competence of the nurse. It would also provide the patient with feedback that is likely to increase the level of satisfaction.
6 References


Informationsblad för deltagare i observationsstudie på akutmottagning

Bakgrund och syfte
Denna undersökning är en del av ett kandidatarbete i kognitionsvetenskap på Linköpings universitet, på uppdrag av Cambio. Syftet med arbetet är att genomföra en undersökning av verksamheten vid akutmottagningars väntrum och att föreslå åtgärder för att göra den mer effektiv för både personal och patienter.

Hur kommer studien att genomföras?
Undersökningen kommer att bestå av en deltagande observation, där försöksledaren "skuggar" personal på akutmottagningen för att lära sig om miljön och arbetsprocessen. Försöksledaren kommer att föra anteckningar och ställa frågor till personalen.

Vilka är riskerna?
Det finns inga nämnvärda risker med undersökningen.

Finns det några fördelar?
Målet med studien är att ge patienter ett mer effektivt omhändertagande och att förbättra personalens arbetssituation. Genom ditt deltagande i studien bidrar du med viktiga insikter som möjliggör detta arbete.

Hantering av data och sekretess

Hur får jag information om resultatet?
Om du vill få information om resultaten av studien, fyll i de relevanta delarna av samtveksformuläret.

Frivillighet
Deltagandet i forskningsprojektet är helt frivilligt och du har möjlighet att avbryta när som helst utan att ge någon förklaring.

Ansvar
Undersökningen görs vid Linköpings universitet av Maria Eckerberg, på uppdrag av Cambio. Vänligen kontakta Maria Eckerberg (marec346@student.liu.se) om du har några frågor.
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7.2 **SUS survey**

Vänligen ringa in det värde mellan 1 (instämmer inte alls) och 5 (instämmer helt) som överensstämmer med din uppfattning för varje påstående. Svara spontant och lägg inte för mycket tid vid varje påstående.

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| 3. Jag tyckte att systemet var lätt att använda. | Instämmer inte alls | 1 | 2 | 3 | 4 | 5 | Instämmer helt |
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| 4. Jag tror att jag skulle behöva hjälp av en teknisk person för att kunna använda systemet. | Instämmer inte alls | 1 | 2 | 3 | 4 | 5 | Instämmer helt |
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| 5. Jag tyckte att systemets olika funktioner var väl integrerade. | Instämmer inte alls | 1 | 2 | 3 | 4 | 5 | Instämmer helt |
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| 6. Jag tyckte att det var för mycket inkonsekvens i det här systemet. | Instämmer inte alls | 1 | 2 | 3 | 4 | 5 | Instämmer helt |
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| 8. Jag tyckte att systemet var väldigt besvärligt att använda. | Instämmer inte alls | 1 | 2 | 3 | 4 | 5 | Instämmer helt |
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| 9. Jag kände mig väldigt säker medan jag använde systemet. | Instämmer inte alls | 1 | 2 | 3 | 4 | 5 | Instämmer helt |
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| 10. Jag behövde lära mig mycket innan jag kunde börja använda systemet. | Instämmer inte alls | 1 | 2 | 3 | 4 | 5 | Instämmer helt |