UX design in a technology driven product development process

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UX design in a technology driven product development process

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Abstract

This master thesis explores how implementing UX design on a product with predetermined technology affects the design process and the methods applied. A UI for the display version of an Axis Door Station is designed from a human-centered design perspective. The development process is based on prototyping and usability studies focusing on the user experience.

The thesis discusses if it is possible to design a better UI for an Axis Door Station through a human-centered design process than a technology driven one, and how the outcome differs if the process emanates from the human behavior instead of technology. It also discusses how the amount of user involvement affects the result and why UX design should be higher prioritised in technology contexts.

The result of the thesis is two UIs developed based on human-centered design. The final usability study show that they are more intuitive than the initially developed UI by Axis Communications AB. The participants of the usability study perceive the new interfaces to be simpler and more pleasurable.

Keywords: Axis Communications AB, User Experience (UX), Human-Centered Design, Usability, Universal Design, Technology Driven Product Development

Sammanfattning

Den här masteruppsatsen utforskar hur implementeringen av användarcentrerad design på en produkt med förbestämd teknologi påverkar designprocessen och de applicerade metoderna. Ett användargränssnitt för display-versionen av en Axis Door Station är designad utifrån ett användarcentrerat designperspektiv. Utvecklingsprocessen är baserad på prototypande och användartester med fokus på användarupplevelsen.

Uppsatsen diskuterar om det är möjligt att designa ett bättre användargränssnitt för en Axis Door Station genom en användarcentrerad designprocess än en teknikdriven process, och hur resultatet skiljer sig om processen utgår från mänskligt beteende istället för teknologi. Den diskuterar även hur mängden användarmedverkan påverkar resultatet och varför användarcentrerad design borde vara högre prioriterat i teknologiska kontexter.

Resultatet av uppsatsen är två användargränssnitt baserade på användarcentrerad design. Det sista användartestet visar att de är mer intuitiva än användargränssnittet ursprungligen utformat av Axis Communications AB. Deltagarna i användartestet uppfattar de nya användargränssnitten som enklare och mer angenäma.

Nyckelord: Axis Communications AB, Användarupplevelse, Användarcentrerad Design, Universell Design, Teknikdriven Produktutveckling

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Lund, January 2020

Agnes Andersson and Jennie Söderbäck

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1 Introduction

The context, purpose and delimitations of the thesis is presented in the introduction along with the expected outcome.

The development of technology is evolving faster and to a greater extent than ever before. At the same time our everyday lives are becoming more and more dependent of interaction with technical devices. The more technology interlaces with the human existence, the more essential it becomes for technology-producing companies to develop their products with human behavior in mind and to consider the experience of the user.

The purpose of the master thesis is to develop a user interface (UI) for an Axis Door Station from a user experience (UX) design perspective in a technology driven product development process. The process of human-centered design is combined with the double diamond process to develop an UI for a product with predetermined hardware and technology, focusing on the graphical user interface (GUI). The thesis is based on a design process with stages of research, concept generation, prototyping, usability studies and evaluations. The development phase is an iterative process. The deliveries are two UI concepts represented with two digital high-fidelity prototypes.

To keep the workload on a reasonable level some delimitations were established. This thesis only focuses on the UI the users interacts with on the door station. The UI has to fit the hardware of the current prototype. There is no focus on which identification method the authorized users use in a double identification system along with their digit code. However, the possibility of a single identification system with a personal digit code is taken into consideration since it has an effect on the UI. The UIs in this thesis will be complemented with audio feedback. The audio feedback is taken into consideration in terms of which parts of the UI should be complemented with sounds, but not what type of sounds it should be.

The expected outcome is one or a few prototyped concepts of UIs for the Axis Door Station based on human-centered design, along with an analysis of how the process is adapted to fit the predetermined technology.

An aim of the thesis is to introduce a new way of thinking of product design at Axis Communications AB (Axis). The main part of the products Axis develops does not have users interacting directly with the physical products, other than during installation. The door station therefore creates new demands on the product development process due to its more complex UI. As a consequence, the human users and their abilities must be more considered in the design process.

2 Background

The background for the thesis is presented in this chapter. This is where the company and the product that the thesis work is based on are presented.

2.1 Axis Communications AB

Axis is a company part of the Canon Group operating around the world. Axis works with network video and audio solutions, analytics and access control to contribute to the protection of people and property, process optimization and increasing business efficiency and information access (Axis Communications AB, 2020).

2.2 The Axis Door Station

This thesis focuses on one of Axis' door station solutions. The door station is a security device placed in connection to doors that requires access. It combines video surveillance, two-way communication and access control.

The door station is constructed with a screen, camera, movement sensor, card reader, microphone and speaker. See figure 2.1. The screen consists of a touch display and an external touch button placed below. The GUI is adjustable, while the button is fixed. The focus area in this thesis is how to optimise the UI using the display and button. The door station can be connected to a single or double identification system, in where the users identify themselves in one or two ways to unlock the door.

Dimensions of the Axis Door Station: 245x140 mm
Dimensions of the display: 104x59 mm

Figure 2.1 Axis Door Station

2.3 Axis' Customers

Axis customers are distributors of security systems and their supply chain is displayed is figure 2.2. The distributors provide resellers and system integrators with the products which in turn provides the end customers with them as a part of a security system. The end customers are owners of commercial real estate or social properties. Commercial real estate includes for instance offices, warehouses and retailers and social properties refers to hospitals, schools, fire stations, jailhouses etc. The Axis Door Station will be placed at the end customers' entrances that requires access. It will not be available for apartments and private housing. Axis target group is international companies worldwide. A large part of Axis sales is in the US.

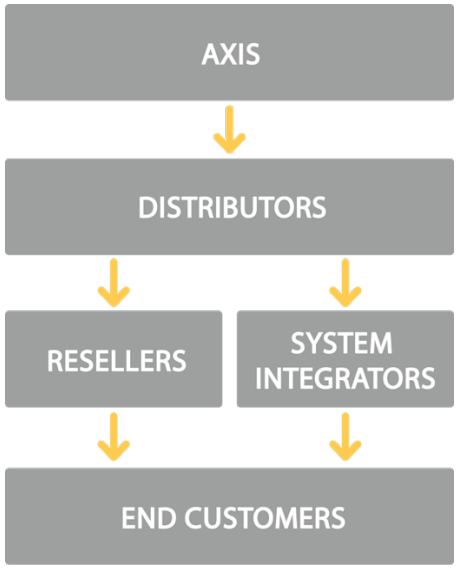


Figure 2.2 Supply chain of Axis' products

2.4 Conditions for the thesis

The Axis Door Station with a touch display is not yet launched on the market. It is an update of a previous model of the door station under construction at Axis during the period of this master thesis. This means that the Axis staff is working on solutions and features of the UI in parallel. Working with the design of the UI in parallel with the team at Axis comes with challenges of constantly changing conditions. The design of the UI developed by Axis is not yet finalised in the beginning of the thesis work which limits the possibility of evaluating a current version. Examination and evaluation of the current UI is performed anyway, but with the knowledge that it is not yet fully established.

The level of secrecy of the not yet launched product is another condition that changes over time. For that reason, the width of the test group in the early usability studies is narrow. Conditions regarding some design aspects of the hardware affecting the UI, such as the function of the external button, also changes over time. These changing conditions affects the decision making in the thesis. Another condition that limits the thesis work is that most of the hardware and the technology of the door station is however already established. Therefore, a complete human-centered design process is not possible.

3 Theory

The theory that the thesis is based on is presented in this chapter.

3.1 User Experience Design (UX Design)

UX design is about the user's perceptions and responses while using a product, system or service. It is a keystone in the process of human-centered design. UX includes all the users' emotions, beliefs and preferences that occur before, during and after the use of a product. Usability is highly important in UX-design. Preece, Rogers and Sharp (2002, p. 50) defines usability as seeking effectiveness, efficiency and user satisfaction. In other words, usability is how well a system, product or service allows a specified user to achieve a specific goal. Usability is an essential part of this thesis, especially the softer values such as user satisfaction.

3.2 The Seven Fundamentals Design Principles

The seven fundamental design principles formulated by Norman (2013, p. 71) is a helpful tool for designers to have in mind during a design process. They describe the different aspects that affect the users and the actions they decide to take when interacting with the product. These aspects should be considered in the design process to be able to make the users understand how the product works and what they can achieve with it. The principles are relevant for any products that are designed for interaction, such as the Axis Door Station. The seven fundamental design principles are described below.

- *Discoverability.* Defines how well the user can determine what actions are possible. The term also includes letting the user know the current state of the device.

- *Feedback.* Information presented to the user after an action. The feedback shows the user the result of the action and if the current state of the product or service is changed after the action. Feedback for example houses confirmations and warnings.

- *Conceptual Model.* The mental model that people carry of how a task should be done. The mental model does not have to match how the device actually works, but it helps the user to relate to a familiar process. The mental model is used to create a conceptual model for the device. The conceptual model enhances discoverability and evaluation of the results. The design should thesis all the information needed to create a good conceptual model of the system, leading to understanding and a feeling of control for the user.

- *Affordances.* Design aspects which suggest how an object or service should be used. They are visual clues to clarify the function and use.

- *Signifiers.* Symbols or signs that tell the user about possible actions and what they lead to. Effective use of signifiers ensures discoverability and that the feedback is well communicated and understandable.

- *Mapping.* Helps the user to orient themself in an interaction flow. Mapping refers to the relationship between controls and their actions. It enhances the design through a clear and comprehensible layout.

- *Constraints.* Prevents the user from making the wrong actions. Guides actions and eases interpretation by providing physical, logical, semantic, and cultural obstacles.

3.3 Universal Design

According to Lidwell, Holden and Butler (2003, p.14) the principle of universal design, also known as accessibility, is to design for people of various abilities without special adaptation or modification of the product,

accommodation or service. Universal design consists of the following four characteristics.

- *Perceptibility.* This is achieved when everyone regardless of sensory abilities can perceive the design. This is done by presenting information redundantly using textual, iconic, and tactile coding.

- *Operability.* This is achieved when everyone regardless of sensory abilities can use the design. The intention is to make the design accessible to everyone without physical effort.

- *Simplicity.* This is achieved when everyone regardless of previous experience can easily understand and use the design. Literacy or concentration level should not affect the use. This is done by removing unnecessary complexity.

- *Forgiveness.* This is achieved when the design minimizes the occurrence and consequences of errors. This is done by the use of good constraints, affordances and feedback and by including reversible actions and safety nets.

3.4 Ergonomics and Hedonomics

Both ergonomics and hedonomics are important factors in terms of UX design. The term ergonomics refers to design aspect that make a product safe and functional, the prevention of pain. Hedonomics refers to the design aspects that makes the usage of a product pleasurable, the promotion of pleasure. The design aspects, and specified needs, can be sorted into a hierarchy according to Hancock, Pepe & Murphy (2005). The hierarchy is illustrated in figure 3.1. The illustration shows that the hedonomics of a product is only considered after the ergonomics has been approved.

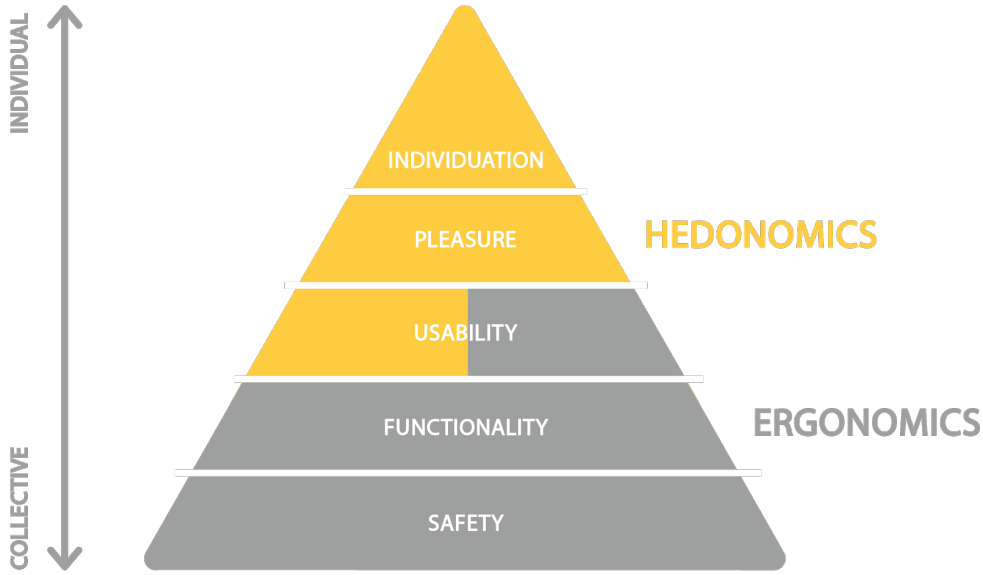


Figure 3.1 Hierarchy of design aspects.

3.5 Prototypes

A prototype is a mock-up of a product used to perform usability studies during a product development process. According to Design council (2015) prototypes help finding unanticipated problems with creative ideas and gives insight into how the design will be used before a finished version is created. In the early stages of the design process a simple prototype can be used to test underlying principles, while in late stages a more accurate prototype is required to refine details in form and function.

3.5.1 **Low-Fidelity Prototypes**

As described by Rudd, Stern and Isensee (1996, p. 78) low-fidelity prototypes (lo-fi prototypes) are constructed quickly and provided with no or limited functionality. They can demonstrate the structure or the look of the design but do not show how the applications operate. Lo-fi prototypes are created to communicate, educate and inform and can be simple sketches on paper to represent a digital interaction flow. They are a simple and efficient way of communicating an idea or a concept early on in the process without putting in too much effort. Lo-fi prototypes signal that the product is not yet finished and that there is much more work to be done. The roughness of the prototypes invites participants in usability studies to give feedback and the designers to easily make quick changes.

3.5.2 **High-Fidelity Prototypes**

High-fidelity prototypes (hi-fi prototypes), as described by Rudd, Stern and Isensee (1996, p. 78), allows complete functionality and are independently interactive. Unlike lo-fi prototypes, hi-fi prototypes enable test participants to operate the prototype as if it is the final product. Hi-fi prototypes are a great tool for usability tests to refine details but are time consuming to create and adjust. A hi-fi prototype may also inhibit the test participant to give constructive feedback since it appears to be a finished product. It is therefore more suitable for usability tests in the late stages of a development process than early stages.

4 Process

The design process of the thesis is presented in this chapter.

4.1 Human-Centered Design

A Human-centered design process focuses on adapting the technology to the perspectives of a human user, rather than the other way around. It aims to make interactive products usable and useful by focusing on the users and their needs and preferences. This approach enhances the usability of the product. It should include the following principles according to ISO 9241-210 (2010):

- The design is based on an understanding of the users, tasks and environments
- The users are involved throughout the design and development
- The design is driven and refined by user-centered evaluation
- The process is iterative, which implies that the design is revised and refined when new information comes in hand.
- The design addresses the entire UX
- The designers include multidisciplinary skills and perspectives.

These principles are the foundation for the approach of this thesis. They will be applied and considered in the different phases of the design process. One of the many challenges though is that the technology of the product has already been established without thorough testing on human users. These conditions will affect the methods used in this thesis and its outcome.

4.1.1 **Iteration**

In human-centered design the purpose of iterating is to enable continual refinement and enhancement according to Norman (2013, p. 229). An iterative process means that the design is revised and refined when new information comes in hand. This is illustrated in figure 4.1. New information can be results from usability tests or technical limitations. The iterations consist of prototyping, testing and evaluating repeatedly until a satisfying result has been reached. Norman also mentions that for every cycle of iteration, the ideas become clearer, the specifications better defined and the prototype gets closer to the final product.

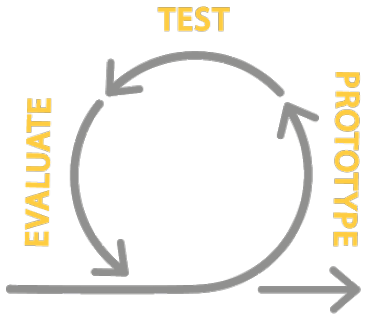


Figure 4.1 Visualisation of an iteration.

4.2 The Double Diamond Process

To keep the thesis in a reasonable time frame and to be able to deliver a concrete outcome this thesis has followed the Double diamond process developed by the Design Council (2005). The Double diamond process and the Human-centered design process complement each other since one of the methods is a structure while the other one is an approach in the way of thinking. The Double diamond process is based on the idea of taking turns of divergent and convergent phases. A divergent phase consists of exploring and broadening and a convergent phase consists of narrowing down and defining. The structure of the Double diamond is built up by the four phases discover, define, develop and deliver illustrated in figure 4.2. The outcome of the two first phases is a definition and the final outcome is a solution to the initial problem.

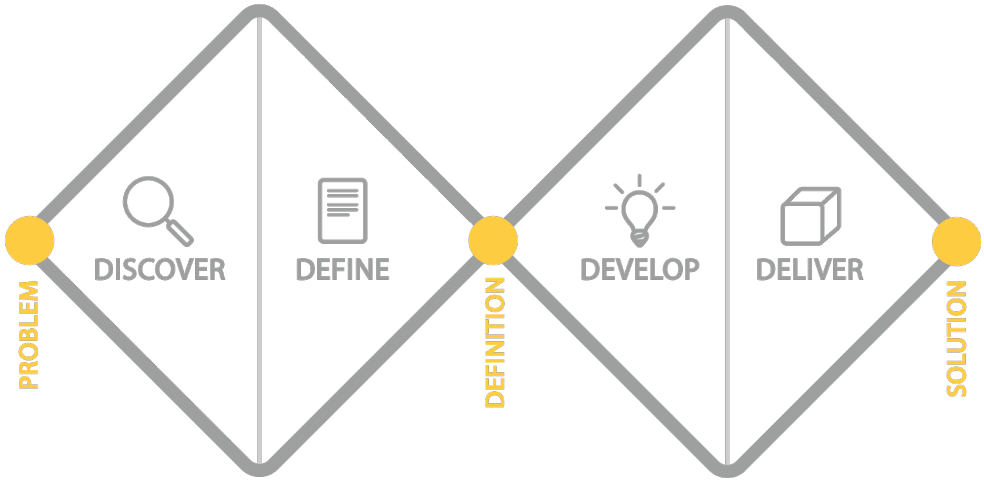


Figure 4.2 Visualisation of the Double diamond process.

- *Discover.* The initial phase is a divergent phase for discovery and exploration of the problem. Insights, information and inspiration are gathered in this phase.

- *Define.* This is a convergent phase where the discoveries from the initial phase are analysed and defined into a definition, the design brief. The design brief describes the purpose, the delimitations, the limitations and the desired outcome of the thesis. The target group is also identified. It is a guideline for the upcoming phases of the process

- *Develop.* During the develop phase solutions are created, prototyped and tested. This phase is an iterative phase and the main focus of this thesis.

- *Deliver.* In the final phase the solution is finalised and presented.

5 Discover

The aim of the initial phase (figure 5.1) of the Double diamond process is to create a base for the design brief through gathering of information, gaining insights and inspiration. An understanding of the product and the user's expectations needs to be established. This is done by examining the current prototype, interviewing Axis staff with particular insight in areas related to the product, benchmarking and investigating a metaphor for the door station.

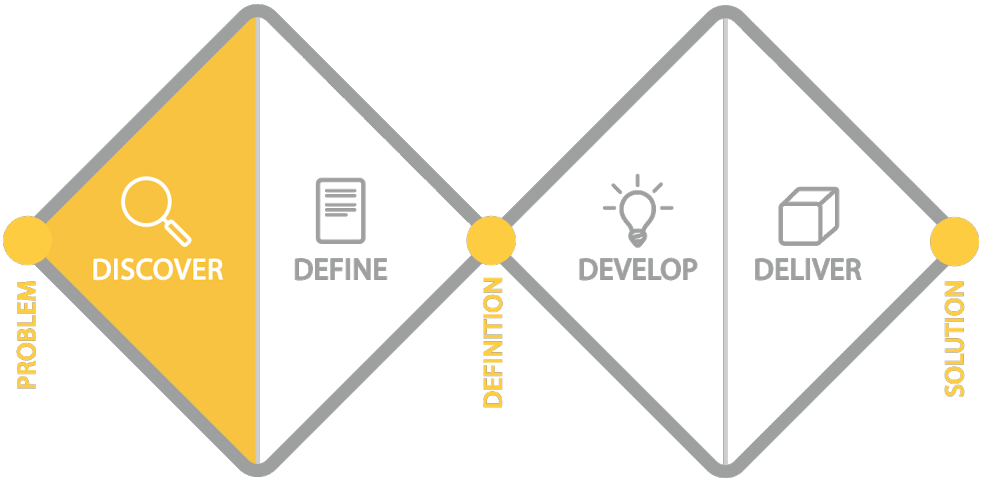


Figure 5.1 Discover in the Double diamond process. Discover is a divergent phase for discovery and exploration of the problem. Insights, information and inspiration are gathered in this phase.

5.1 The Current Prototype

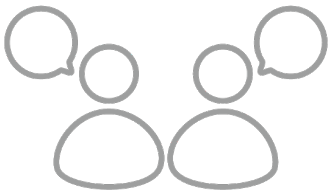
To understand what the thesis is based on, one of the first steps in Discover is to examine and analyse the current prototype of the Axis Door Station, along with provided screenshots of the GUI. The explored areas include the presentation of information, the graphic design, the possibilities of adapting the UI and features such as the search, call and keypad feature. An evaluation of the usability of the prototype and the application of the seven fundamentals of design is made. The analysis is based on the current design propositions at the time even though the final design is not yet established by Axis.

A usability study is performed with the method A/B testing and observation. A/B testing according to Martin and Hanington (2012, p. 8) is a method that is applied to compare two versions of a design. To determine which design that performs statistically better against a predetermined goal the participants randomly gets assigned version A or version B of the design. Tests are then held until it is clear which version better delivers the desired outcome. The method does not further evaluate the optional designs, it simply compares them to one another and should therefore only be used in addition to other user survey studies.

As a part of the product discovery Axis is helped out conducting a planned test of a search feature planned for the first release of the product. Two design propositions for the feature, developed by Axis, are evaluated and compared with A/B testing in an informal usability study. Informal usability studies are according to Magnusson, Rassmus-Gröhn, Tollmar, Deaner (2009, p. 55) testing a prototype during informal circumstances, in this case letting people who walk by test it while being observed. The tests are held outside of the main reception at Axis. During the tests the door station is mounted on a portable wall and the participants are given a scenario and a task for which they have to interact with the door station to

complete. The scenario explains the context and that they are there to visit a certain person for a meeting. The test has 40 participants, mostly employees at Axis in varied ages.

5.2 Interviews at Axis



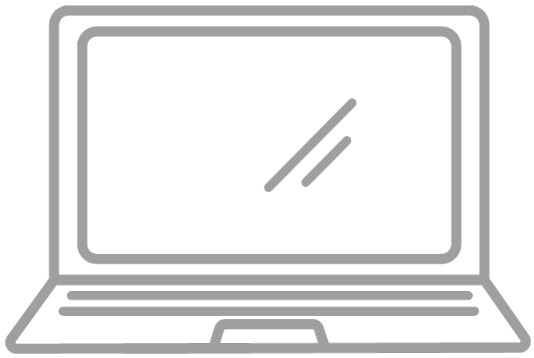
To gain insight into the product and the customers' expectations several meetings are held with Axis staff involved with the door station. The aim of these interviews is to get a deeper understanding of the products purpose and how the UI can help fulfilling it. Areas discussed during the interviews is the area of use, customers and their expectations and desired features.

- *Product managers.* The product manager is the person in charge of a certain product. The product manager is focused on business visions and functionality rather than technical solutions. Meetings are held with the previous and current product manager for the Axis Door Station.

- *Product specialists.* A product specialist is the technical hand of the product owner, an expert in the technical area of the product. They help with the technical issues that are too advanced for the customer support to solve, and mediate customers' needs and opinions when new designs are created. Meetings are held with the two current product specialists, one focusing on access control and one focusing on network, and a previous product specialist.

- *Global sales engineer.* A global sales engineer is a technical support for the sales team. Their purpose is to win sale arguments through their technical knowledge of the product and to try out new solutions.

5.3 Benchmarking



To establish what is currently on the market a brief benchmarking is executed. Competitive products are identified and their UI are examined. The purpose of the benchmarking is to get an idea of customers' expectations, finding potential selling points and get inspired.

A general benchmarking of GUIs is also made. The aim is to explore different ways of communicating information and interaction on a display and investigating what graphic style is modern. The method of studying GUIs were observing them and looking for patterns regarding the design, layout and mapping. The design and use of symbols is a big part of the benchmarking.

A focus in the benchmarking is how to design for user groups with special demands. One of the companies that is examined is Doro, a mobile phone manufacturer with seniors as their target group. Some other areas explored are apps for learning languages and how to adapt a text on a wall for easy reading. One of the findings is the common use of images or symbols to help with language difficulties. The use of symbols is therefore specifically studied.

5.4 Metaphor

Since the Axis Door Station is more advanced than most of the similar products on the market it is difficult to make helpful observations of and comparisons with other products. To explore the possibilities for a door station with a more advanced technology a metaphor for the door station is chosen; a reception. This metaphor represents that the Axis Door Station is an advanced product that could help visitors with tasks a reception would otherwise do. To gain insight to what the most common errands are for visitors at commercial real estate and social properties, receptionists at such places are contacted. A questionnaire is distributed to them by email and eleven answers are received. The questions concern common issues and errands for visitors, and in what way the receptionists help them. The questionnaire is formed according to Magnusson, Rassmus-Gröhn, Tollmar and Deaners (2009, p. 33) who recommend a mix of closed and open questions to ensure the statistics of the result to be useful.

5.5 Results from Discover

5.5.1 **Results of usability studies of the current prototype**

The usability study gives more insight to the product than only a perception of the two search features being compared. It also shows how the users interact with and perceive the product as a whole. The usability study shows that it is very common for the participants to bend over to see the display more clearly. This indicates that the symbols and text is too small. It also shows that people are more inclined to remember and look for last names than first names in a name list. There is a slight tendency to call the

reception instead of trying to find the name in the name list. Statistics indicates that people with an age over 40 struggles more to find different features and to understand how they work. Another finding concerns the participants expectations of the product. The usability study shows that it is common that people already have a mental model of how a name list is constructed, and therefore get confused if the layout differs from that model. One example is that most people are looking for a search feature when they reach a name list but cannot find it if it is put in an unexpected place.

"Oh my gosh, so many names...!"

This quote expresses the frustration people who has to scroll through a long list of names experience. A result of this usability study is that none of the two alternatives for a search feature are satisfying.

5.5.2 **Results of Interviews at Axis**

The most important acknowledgments from the interviews are which functions that are required in the UI and what the expectations are from the stakeholders. The interviewees all agree on the importance of clear feedback. Another thing that is indicated is that the core value of Axis, a professional security business, should be clear throughout the entire UI.

The main functions required in the UI are the following:

- Call a call-group, for example a reception or department
- Call a specific person
- Allow identification to grant access and unlock door.

5.5.3 **Results of Benchmarking**

The result of the benchmarking is that there are few as advanced products on the market as the Axis Door Station. Most of the products are not as advanced in the interaction in terms of the display and camera.

Modern GUIs has simple colour blocking without gradients or shadows, and simple rounded shapes.

The following questions are answered during the symbol study.

- *Which variations of symbols are acknowledged to represent specific functions?* A large variation of symbols used to represent functions and features are found. The symbols are more or less frequently used and acknowledged to represent specific features. It can be expected that the users understand the frequently used ones without further explanation, for example the symbols for making and ending a call, see figure 5.2.

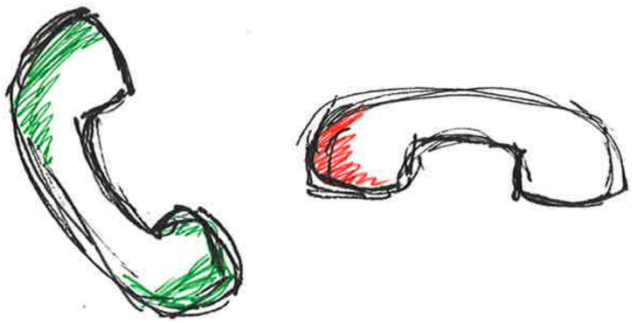


Figure 5.2 Symbols for making and ending a call.

- *How are the placement of symbols used to help the user navigate? Web, smartphone or other applications?* The placement and use of symbols differed between smartphone apps and applications on a computer. The conclusion is that the difference is due to the situations and contexts in which they are used. A smartphone has a small display size, touch display and are used on the go, while a computer has a large display, often an external pointer and are designed for more advanced use. The context of the door station was considered being more similar to the context of a smartphone. It should therefore use symbols and navigation similar to the ones found in a smartphone.

- *Which symbols are modern?* The modern design of symbols is simple, with few details and does not differ in colour. Round shapes

and thin lines are more modern than sharp edges and thick lines, see figure 5.3-5.5.

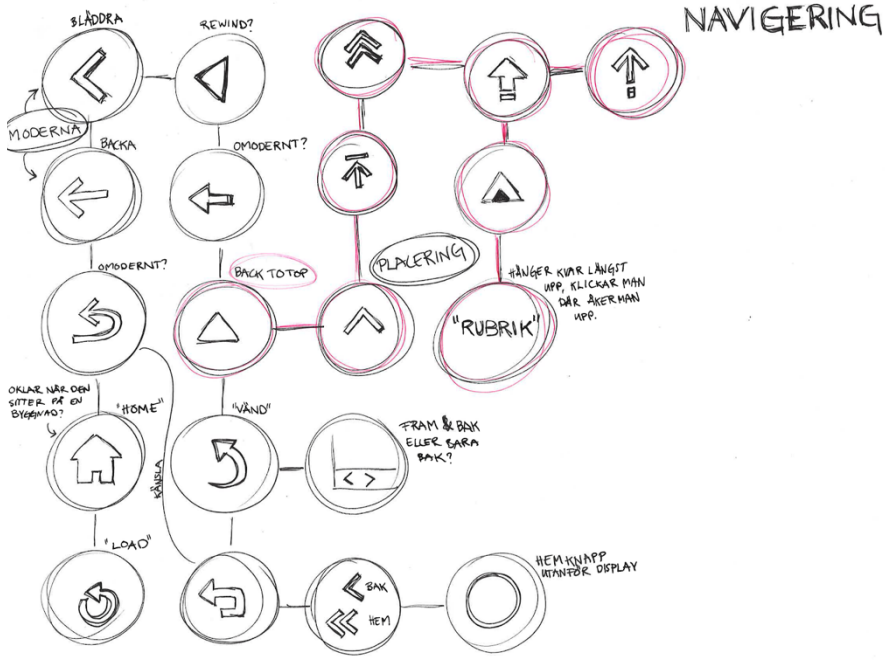


Figure 5.3 Symbol study of navigation features.

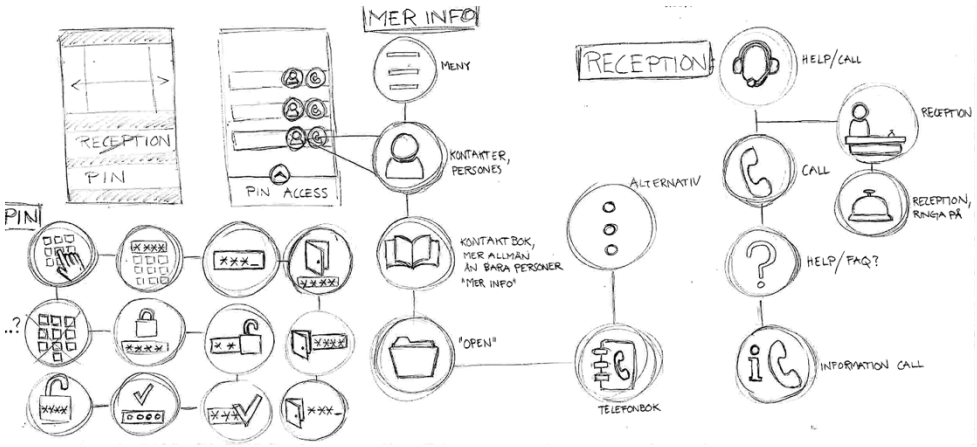


Figure 5.4 Symbol study of personal digit codes, reception and other information

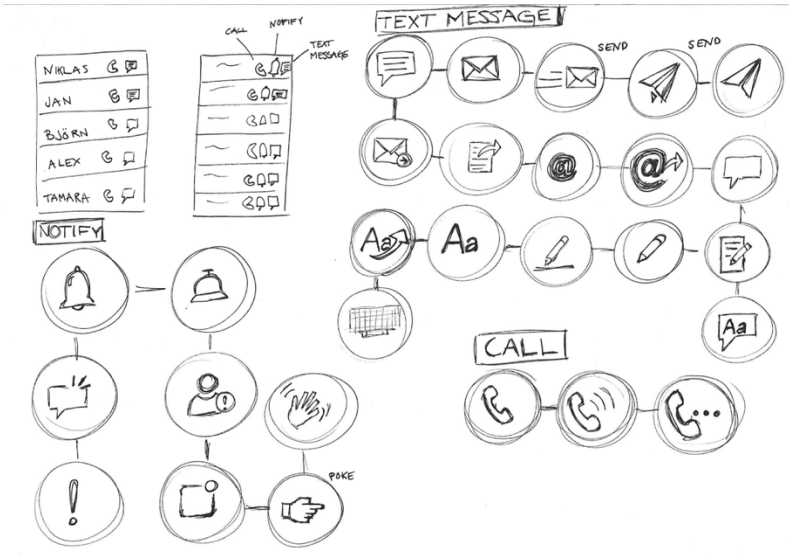


Figure 5.5 Symbol study of notifications and text messages.

5.5.4 **Results of Questionnaire to Receptionist**

A conclusion of the questionnaires was that the most common errands for visitors are to reach a specific person or to sign up for a meeting. Other common errands are to reach a department or to get directions to a specific location.

5.6 Conclusion from Discover

The results from Discover are considered and refined in Define. Which functions that should be included in the UI are further examined along with the direction for the graphic design approach and symbol design. Another finding that is considered further during the thesis is the technical limitation of the product regarding the touch display and the problematics of the current GUI. The needs of the potential users that is established is also defined further in Define.

6 Define

The focus in this phase, see figure 6.1, is to narrow down and summarise the findings from Discover into a definition, the design brief. The design brief describes the purpose and expected outcome of the thesis as well as the users and the delimitations of the thesis.

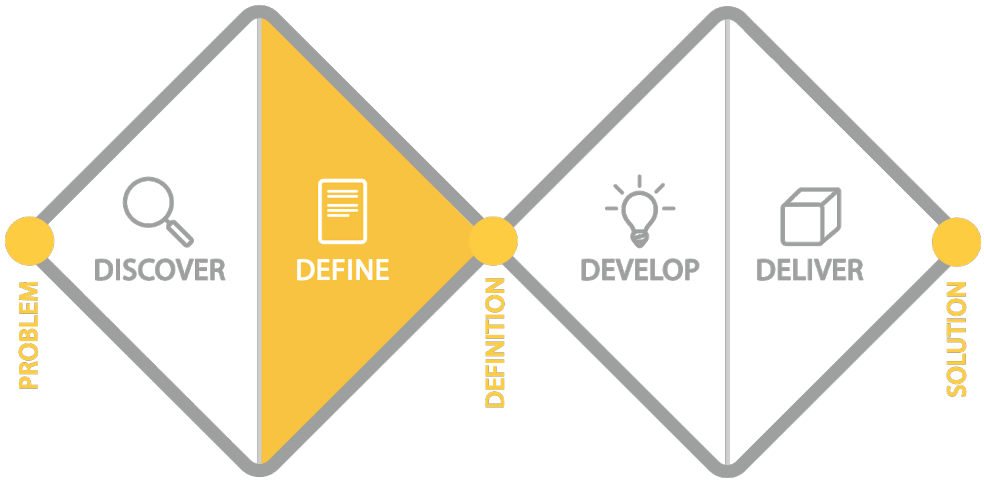


Figure 6.1 Define in the Double diamond process.

6.1 Purpose

The purpose of this thesis is to explore how implementing UX design on a product with predetermined technology affects the design process and the methods applied. The aim is to design a UI for an Axis Door Station with predetermined technology from a human-centered design perspective. A comparison of the result from this process and the initially developed UI are also part of the purpose.

6.2 Functional Analysis

To define what the outcome should fulfill a functional analysis is created. Magnusson, Rassmus-Gröhn, Tollmar and Deaner (2009, p. 25) describe a functional analysis as a list of functions that a product can have. The functional analysis should focus on what the product should do and not how it does it. The functions listed are classified as: main functions (MF), necessary functions (N), desired functions (D) and Unnecessary functions (U). The functional analysis is based on the findings from Discover and is updated during the process as new insights are received.

6.3 Graphic Style and Tone of Voice

The aesthetics of the GUI is not a focus of this thesis, but it is still an essential part of the perception of the product and therefore a brief investigation of the graphic style for the GUI is made. To define the graphic style and tone of voice discussions are held with Axis staff involved with the door station and the general tonality of Axis. Meetings are held with product managers, product specialists, a global sales engineer, a graphic UI/UX designer, a technical writer and a terminology and tonality specialist. This is to get a broader and deeper insight to what the tonality and graphic style should be for the door station and its GUI.

The diagram in figure 6.2 is created and used as a discussion tool. The axes are scaled from complex to simple and playful to strict. A complex interface has a lot of leading information and texted instructions while a simple interface has a more minimalistic layout with little information and text, perhaps only symbols. A playful interface is created by the use of fun and crazy shapes, bright colours and animations, while a strict interface has regular shapes and few colours and animations. Examples of UIs are placed in the diagram for reference.

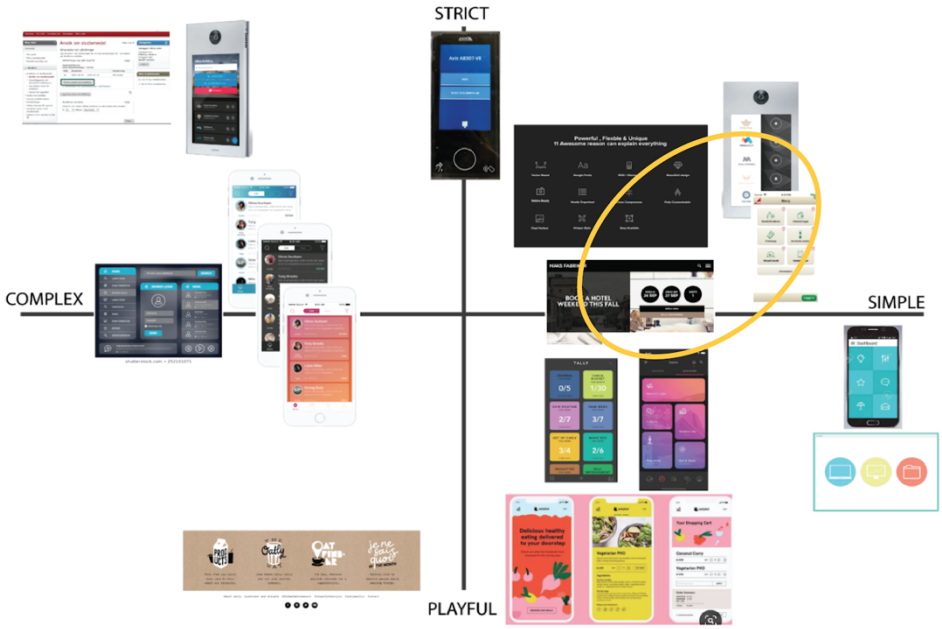


Figure 6.2 Diagram of graphic style.

The UI of the Axis Door Station should be perceived as a professional safety product while providing a pleasant UX. The appropriate graphic style for a professional safety product is in this thesis defined as rather strict and as simple as possible with little or none festive colours, shapes, animations and features. If it is too strict or complex there is a risk that the user perceives the device as uninviting and does not understand that they should interact with it. If it is too playful it seems unprofessional and not like a security device. The conclusion of the discussions is that the UI of the door station should be placed somewhere within the yellow circle. An argument for being in the lower part of the circle is hedonomics. The hedonomics of a UI can be improved by adding some playfulness to make it more casual. As described by Gutgold (2010) a too strict UI makes the user less patient. If some playfulness is applied to the UI the user could get a more pleasant experience when navigating, which is connected to the user's patience. Playful elements also indicate that it is supposed to be interacted with and confirms to novice users that they are allowed to do so. For a door station it is more important that the user is encouraged to interact with it than a fun experience while using it.

The result of the discussions with the diagram gets along with Axis' internal guidelines for tone of voice in text (figure 6.3) provided by the terminology and tonality specialist at Axis.

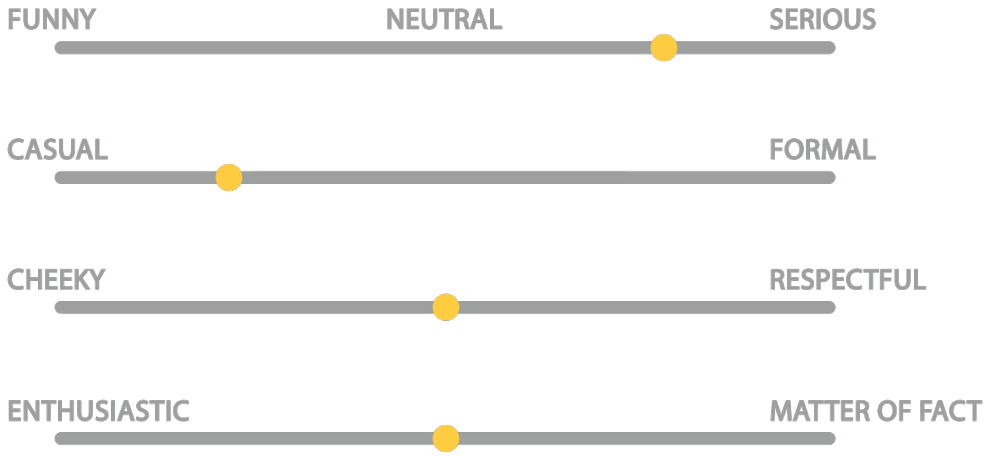


Figure 6.3 Axis guidelines for tone of voice provided by the terminology and tonality specialist at Axis.

6.4 Users

The primary users in this thesis are the ones who interact with the GUI of the door station and not the ones who install or adjust the settings for it. The UI has to consider and fulfill the needs of two separate user groups.

- *Authorised users.* The authorised users are users with access who will use the product on a daily basis.

- *Visitors.* The visitors are users who does not have access to the building and therefore needs to contact someone on the inside.

The users are people of various ages with different occupations. It includes people with light cognitive impairment, color blindness, partially compromised vision or hearing and language barriers.

6.4.1 **Personas**

Since Axis do not have direct contact with the end customers it is difficult to reach the users of the door station. The users are a wide group of people with various abilities and prerequisites, which contributes to the difficulty of reaching a representative group of users. To represent the broad spectrum of possible users four personas with different prerequisites and abilities are created. Personas are concrete fictitious descriptions of potential users according to Magnusson, Rassmus-Gröhn, Tollmar and Deaner (2009, p. 21). Usually more than one persona is created to include several perspectives. The personal traits of a persona help the designers to sympathise with the users. It can be a useful tool in discussions among the designers to make sure that everyone involved in the product has the same goal.

6.4.1.1 Claes 53, Authorised User

Figure 6.4 Claes.

Claes is a well-educated businessman with impressive language skills. He is a confident and proud man, and he values a confident image. Claes has an active lifestyle and exercises a variety of outdoors activities such as skiing and hiking. He likes to have the latest gear and spends a lot of money on exclusive equipment.

Claes is colour blind and especially struggles with green and red. This sometimes makes him feel limited. When he encounters technical difficulties or comes across something, he does not understand it bruises his ego and he gets uncomfortable. See illustration of Claes in figure 6.4.

Claes uses the door station every day at his office and has a personal digit code for access.

6.4.1.2 Solveig 68, Visitor

Figure 6.5 Solveig.

Solveig has been retired for a few years and now her main occupation is being a loving grandmother who likes to surprise her loved ones. Solveig has a passion for social issues and is a fighter for the poor and disadvantaged in society. She has been engaged in several non-profitable charities and she enjoys reading books as well as newspapers. She never misses the ten o'clock news.

She is an alert 68-year-old but due to many years of practicing the clarinet she suffers from arthritis. Her vision is compromised by cataract and she is currently waiting for surgery. Her English is limited. See illustration of Solveig in figure 6.5.

Solveig comes across the door station when paying her daughter a visit at work.

6.4.1.3 Miranda 31, Visitor

Figure 6.6 Miranda.

Miranda is an ambitious lawyer. She went straight from high school to law school and passed her studies flawlessly. Miranda highly values peoples positive personal and professional perception of her. She owns a jack russell, Selma, who she is practicing agility within her spare time.

Miranda values her time and wants to spend it on things that bring value to her life and surrounding. Therefore, she appreciates efficiency and is impatient regarding unnecessary obstacles in her way, big or small.

Miranda encounters the door station when she is on her way to a job interview at a well-known law firm and does not want to be distracted. See illustration of Miranda in figure 6.6.

6.4.1.4 Andreas 19, Visitor

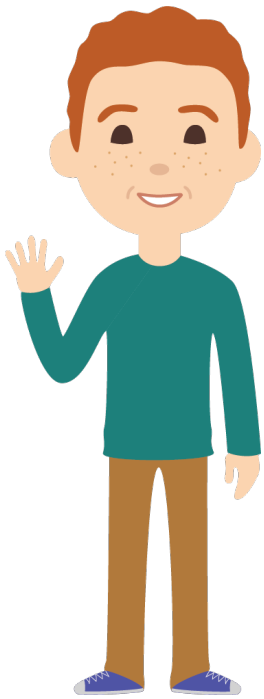


Figure 6.7 Andreas.

Andreas is a high school student. He has a cognitive impairment which causes him to need more time to handle his studies. In his spare time, he likes being creative and especially enjoys painting. One weekend every month he goes to an organised camp with other teenagers with disabilities. He knows the people at the camp very well.

Andreas has a hard time comprehending and processing a lot of information at once. Information presented in long texts with advanced words is beyond his cognitive capacity. Andreas struggles with remembering and interpreting text-based instructions but has a good ability to decipher and recognise symbols and colours.

Andreas encounters the door station when he is visiting his father, Christer, at his office located close to Andreas' school. See illustration of Andreas in figure 6.7.

6.5 Delimitations

To keep the workload on a reasonable level some delimitations were established.

This thesis only focuses on the UI the users interacts with on the door station. The design of the web application where the settings for the door station are applied are not looked into.

The UI has to fit the hardware limitations of the current prototype. The shape, size and components of the product cannot be changed, the technology is predetermined.

Which identification method the authorized users use in a double identification system along with their personal digit code is irrelevant. If the authorised user has a keycard, a tag, an app or identify themselves with biological identification does not affect the design. However, the possibility of a single identification system with a personal digit code is taken into consideration since it has an effect on the UI.

The UIs in this thesis will be complemented with audio feedback. The audio feedback is taken into consideration in terms of which parts of the UI should be complemented with sounds, but not what type of sounds it should be.

The typical number of names in a door station is no more than 20 people or departments, typically 3-5 names per company. However, there should not be a limit for the possible number of names.

UX aspects connected to the hardware other than the display performance has not been considered in this thesis.

6.6 Expected Outcome

The expected outcome is one or a few prototyped concepts of UIs for the Axis Door Station based on human-centered design, along with an analysis of how the process is adapted to fit the predetermined technology.

6.7 Design Brief

- *Purpose.* Designing a UI for an Axis Door Station with predetermined technology. Explore how the late implementation of human-centered design in the design process affects the methods applied.

- *Functional analysis.* The functional analysis (table 6.1) lists the functions of the outcome. The functions listed are classified as: main functions (MF), necessary functions (N), desired functions (D) and Unnecessary functions (U).

Table 6.1 Functional analysis

Rating	***Function***
MF	Allow identification to grant access
MF	Call person
MF	Call call-group
N	Indicate safety
N	Offer legibility
N	Invite to interaction
D	Call extension number
D	Adjust sorting
D	Send message or notification
D	Receive message or notification
D	Be perceived as modern

- *Graphic style and tone of voice.* The appropriate graphic style for a professional safety product is defined as rather strict and as simple as possible with little or none festive colours, shapes, animations and features. The tone of voice should be serious but casual.

- *Users.* The users can be divided into two groups; authorised users and visitors. The users are people of various ages with different occupations and abilities.

- *Delimitations.* The areas outside of the delimitations of this thesis are:

    - The design of the web application
    - Identification method of authorised users other than single identification with a personal digit code
    - Type of audio feedback
    - Aspects connected to the hardware other than the display performance.

    The technology of the product is predetermined. The shape, size and components cannot be changed.

- *Expected outcome.* One or a few prototypes and an analysis of the process adapted to the predetermined technology.

7 Develop

This is an explorative phase, see figure 7.1, where ideas are produced, further developed and adjusted. Concept generation and usability studies are the foundation of this phase. During three iterations solutions are prototyped, tested and evaluated, see figure 7.2. The phase begins with general brainstorming sessions that end up in three basic concepts that form the foundation for the the first iteration. The three iterations are based on one prototype each. The complexity of the prototypes increases in each iteration.

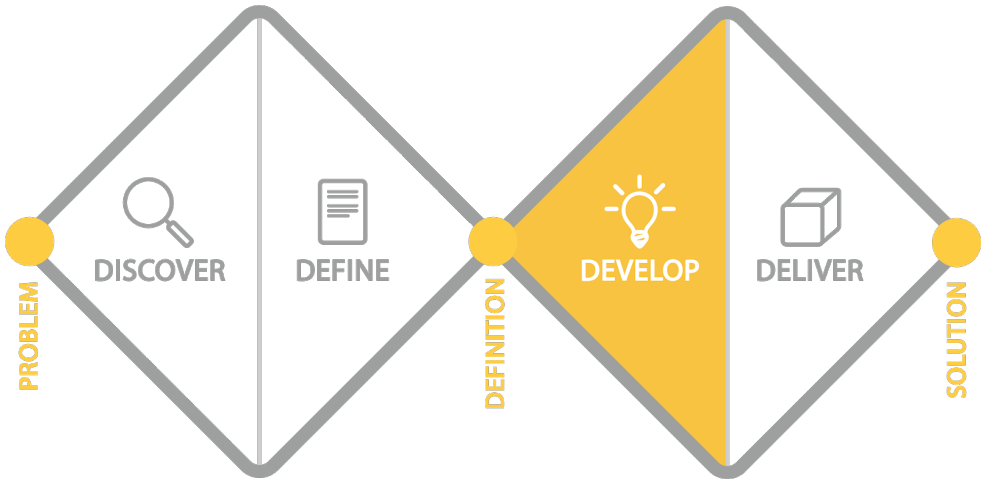


Figure 7.1 Develop in the Double diamond process.

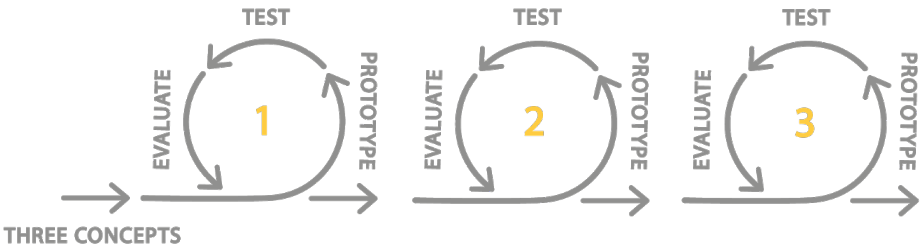
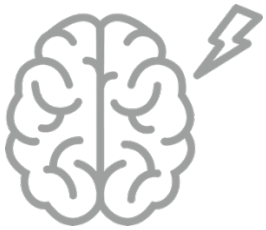


Figure 7.2 The iterative process of the develop phase.

7.1 General brainstorming and concept generation

7.1.1 **Brainstorming**



The develop phase begins with a general brainstorming session. Brainstorming is a procedure to generate a large amount of ideas where the following rules described by Wikberg Nilsson, Ericson and Törlind (2015, p. 125) are applied:

- Do not criticise
- Aim for crazy ideas
- Combine and improve the concepts
- Quantity rather than quality

The brainstorming method used here is called braindrawing. It is a method where every team member sketches a number of ideas in a certain amount of time and then passes it on to another team member who elaborates or gets inspired by the ideas. The sketching and passing on continues until a desired amount of ideas is produced. To use sketching instead of talking or writing is a way to stimulate new perspectives and to fuel the creative process. Four sessions of braindrawing with different focuses are held. The focus varies from layouts and interaction flows to specific features. Features such as the search and the calling features are prioritised in the idea generation along with ideas for new features. In addition to the braindrawing individual sketching is done and general discussions about concepts and features are held.

The result from the brainstorming are a large number of ideas for interaction flows, layouts and features. These ideas vary in terms of realism, applicability and match with the design brief, but are all kept for the next step in the process. This is to make sure to not miss a possibility as the rules of brainstorming assures.

7.1.2 **Scamper and Defining Concepts**

The produced ideas from the braindrawing are further developed with the Scamper method. Scamper is a creative method presented by Wikberg Nilsson, Ericson and Törlind (2015, p. 133) which is used to evolve the material from the previous brainstorming sessions. The method is an effective way to ensure that no ideas or concepts are overlooked or forgotten. All the ideas are evaluated and updated with the following points in mind:

- Substitute?
- Combine?
- Modify?
- Put to other use?
- Eliminate?
- Reserve?

The aim of brainstorming is to focus on quantity and crazy ideas, and scampering aims to refine those crazy ideas into something more realistic. Some sketches from the brainstorm is presented in figure 7.3. Scampering evolves and combines the ideas generated in the braindrawing. This makes fewer but more refined and investigated ideas that are more prepared for evaluation. These ideas are evaluated against the design brief and the ideas that fit the brief are kept and the rest are discarded.

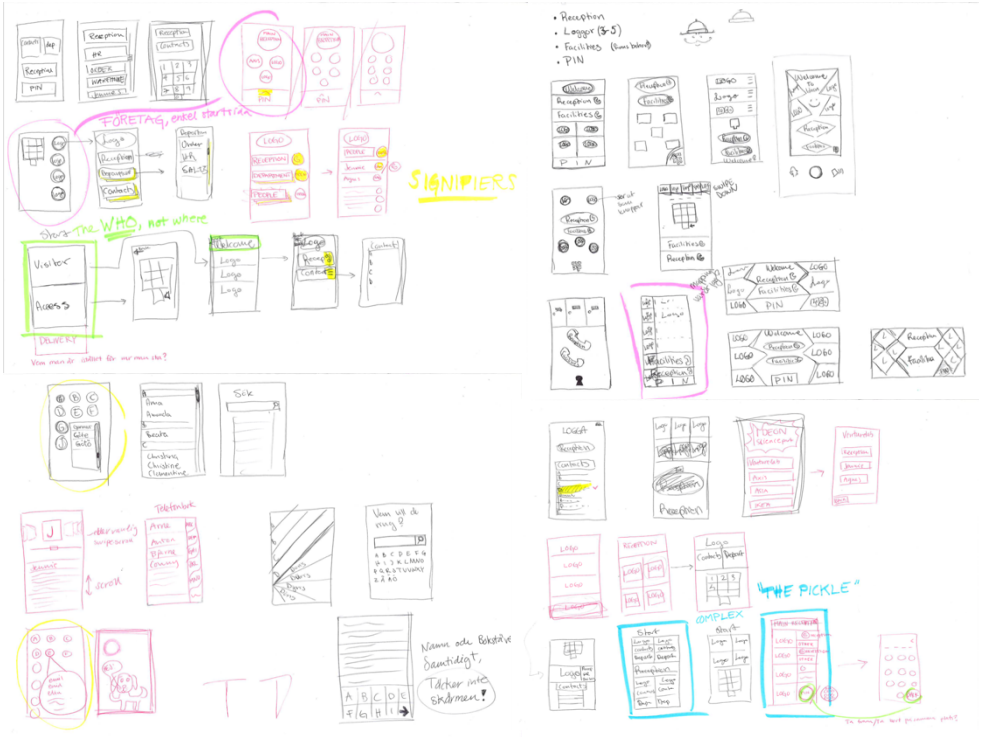


Figure 7.3 Examples of the sketches from the braindrawing sessions.

The remaining ideas concerning the structure of the interaction flow are grouped and defined into three basic concepts focusing on the structure of the interaction flow, the wireframe. The three wireframe concepts concern mostly the initial part of the interaction flow since they mostly define the navigation and start pages. All wireframe concepts contain placeholders for the main and necessary functions from the functional analysis.

- Concept A. Focuses on who the user is and adapts the features displayed after their needs. The start page for concept A is displayed in figure 7.4.

Figure 7.4 Concept A.

- Concept B. Focuses on showing the visitors that they are at the right place and displays the most commonly used features and hides the more unusual ones in a separate menu. The start page for concept B is displayed in figure 7.5. To get to the hidden functions the users will have to press the house symbol in the header.

Figure 7.5 Concept B.

- Concept C. Helps the user achieve their goal with as few clicks as possible. The start page is displayed in figure 7.6. The reception at the top is a call group and for this concept there could be more than one call group on the start page.

Figure 7.6 Concept C.

Along with the wireframes, the result from the scampering is several variations of for example search, call and message features that can be applied in the wireframe concepts. The three wireframe concepts and the variations of features is the foundation for the first iteration.

7.2 The First Iteration

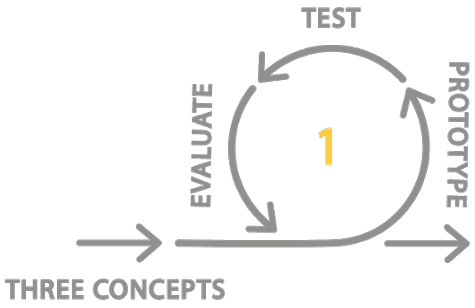


Figure 7.7 First iteration.

In the first iteration (figure 7.7) the delimitations are set to focus on the display only. No regards are taken to the external button due to ongoing discussions at Axis of the button's presence. At this stage it is not possible to involve test participants who are not employed at Axis due to secrecy of the product. This limit the possibilities to reach test participants of a broad spectrum of age, occupation and abilities. To get an as varied test group as possible the test is performed at different departments at Axis.

7.2.1 **The First Prototype**

The first iteration is based on lo-fi prototypes consisting of sketches on paper, see figure 7.8. The prototypes are based on the three wireframe concepts A, B and C. These three basic concepts are complemented with several variants of standard functions such as the search features in the

name list and the call features. New features such as sending or receiving messages and calling extension numbers are also integrated in the layouts.

Figure 7.8 Examples of pages in prototype 1.

7.2.1.1 Layout

This iteration focuses on which features that should be integrated in the UI and their titles, symbols and placement. The placement of the features on the display depend on their need of discoverability. For example, the most commonly used features are placed above the more rarely used ones on the display. The reception is placed at the bottom of the display to encourage users to call the person they are visiting directly.

Colours, fonts, and other graphic design aspects are not considered in this stage.

7.2.1.2 Search Feature

The search feature for the names in the name list is one of the main focuses in the first iteration. Five developed versions of the search feature are prototyped, tested and evaluated in the first iteration. One version consists of a list that includes scrolling while the other variants focus on eliminating scrolling due to the results from the test of the current prototype. The test result show that a lot of test participants are looking for a free-text search feature. Therefore, one of the five variants is based on a free text search. The three remaining versions of the search feature are based on letting the user choose the first letter in the name of the person they want to contact. Then all the names starting with that letter are displayed in a short list. In all the five versions the names can only be found through the search feature. In a scenario where there are too few names in the unit to motivate a search feature the list of names will appear directly, and no search feature will be available.

7.2.1.3 Call feature

The main focus of the call feature is to give the user clear feedback of the state of the call, the volume and the video communication. The call feature will also include signifiers for the optional actions during the call such as volume control. In the scenario of a call getting no answer the user needs to make a decision of what to do next. To help the user in this situation a proposition of appropriate actions is implemented. The proposed actions are to call again, to send a message and to call the reception.

7.2.1.4 New features

One of the new features is a message feature. Its original purpose is to be an aid to deaf and mute people, but also a way of communicating if the person you are trying to contact does not answer. It can also be a way for the receiver of the call to communicate without answering the call, for example by letting the person by the door station know that they are on their way.

Another new function is to call a person whose name is not in the name list of the door station due to integrity reasons. The function is implemented through the feature of calling an extension number. Calling extension numbers means that the visitor can reach the person by entering a received number in a keypad. The extension number method is chosen since it is the easiest way for the person to provide the visitor with the information needed to make the call.

Another addition is complementary information regarding opening hours and propositions for actions if a department you are trying to contact is not open.

7.2.2 **Testing of the first prototype**

Figure 7.9 Test methods in the first iteration.

The usability studies of the first prototype are performed with three methods; single-user tests, focus groups and cognitive walkthroughs (figure 7.9). In this early stage of the develop phase it is important to get qualitative test results. The usability studies focus on discussing and comparing concepts and features to gain a deep understanding of what the participants want the product to be. The usability studies held in the first iteration can be seen in table 7.1. The duration does not include preparation and evaluation of the tests. The focus groups had three participants each and a cognitive walkthrough was made with each of the four personas. To gather data in the usability studies one person acts as a test leader while the other one is observing and taking notes. The same data gathering methods is used throughout all three iteration.

Table 7.1 Testing of the first prototype

Test method	*Number of tests*	*Number of participants*	*Duration (min)*
Single-user test	4	4	45
Focus group	2	6	60
Cognitive walkthrough	4	-	20
Total	10	10	380 (6,3h)

7.2.2.1 Wizard of Oz

Wizard of Oz is a method for testing an UI with lo-fi paper prototypes. As described by Preece, Rogers and Sharp (2002, p. 545) the test participants interact with the prototype as if it is a real product, while a human operates the system to simulate the interaction flow. The participants get a lo-fi prototype placed in front of them and depending on what actions they take another paper takes its place to take them further in the simulated interaction flow.

7.2.2.2 Single-user tests

The single-user test is a usability study with one person at the time. When the participant gets no help from other people the result shows clearly how well the concept works and what parts need immediate updates.

Wizard of Oz is used during these tests and the participants get a scenario where they get to click themselves through an interaction flow in the prototype to reach a certain goal. Then, alternative design solutions, symbols and terminology is presented and discussed with the participant. The data from the tests is gathered through taking notes of observations and statements of the participants during the tests. The data from each test is compiled and applied to the concepts before the next usability study.

7.2.2.3 Focus groups

A focus group is a meeting with potential users with whom a discussion is held regarding a certain question or theme related to a product. According to Wikberg Nilsson, Ericson and Törlind (2015, p. 87) the purpose of having a focus group, instead of individual meetings, is that the participants can build on each other's thoughts and ideas which might give a more profound feedback.

Focus groups are held with three participants at the time to start more vivid discussions. The meetings begin in the same way as the single-user tests with a scenario that the participants get to click themselves through in the prototype with the method of Wizard of Oz while discussing their choices and actions. Then alternative solutions are discussed among the participants. The data from the tests is gathered through taking notes of observations and statements of the participants during the tests.

7.2.2.4 Cognitive walkthroughs

A cognitive walkthrough is a usability study where the designers imagine a scenario from a certain user's perspective. Magnusson, Rassmus-Gröhn, Tollmar and Deaner (2009, p. 29) declares that it is a method where the experience of a user is being considered in a step by step walkthrough of the system made by the designers. It is a simple, but structured way of detecting crucial usability problems. People tend to prefer learning by doing which makes the method a realistic way of noticing usability issues that the users might experience.

Since there are difficulties in reaching a varied group of test participants representing the end users, the personas are used in the last step of the first iteration to complement the user tests. A cognitive walkthrough is made from the perspective of each persona to discover the difficulties not represented in the group of test participants. The scenario of each persona is considered in a step by step walkthrough to make sure their needs were being fulfilled. The cognitive walkthroughs are an effective way to discover not yet encountered difficulties, especially since the possibility to get a varied group of test participants is limited.

7.2.3 **The first evaluation**

Some general observations are made during the first iteration concerning the context of the door station. One of them was that the option to call a general reception in a building housing several companies will not be necessary. If a general reception exists, the assumption is that it will be open for people to visit.

It is common that the participants in the usability studies wants to see if they are at the right door directly. It is important with some indication of that on the start page, like an address or company logos. This also encourage interaction since the page is perceived as more welcoming for the participants.

The topic of main target group is raised during discussions. Is it more important to design for the most common users (the authorised users) or the ones who need most help (the visitors)?

Observations concerning the test method are also made. It was an effective way to fast get relevant feedback and make updates, however the context is

not clear enough for all the participants. Several of the participants do not understand that the size of the display in the prototype is the actual size but expected the real display to be bigger and have more space.

The cognitive walkthrough turn out to be an effective way to discover not yet encountered difficulties, especially since we had limited possibilities to get a varied group of test participants.

7.2.3.1 Evaluation of layout

"The best interface is no interface"

A comment from one of the users is that the interface should only give the user the information absolutely necessary to complete the task. Everything extra can create unnecessary confusion or irritation.

Occam's razor is a design principle regarding simplicity described by Wikberg Nilsson, Ericson and Törlind (2015, p. 149). The principle is a tool to explore, develop and select among different alternative designs. The goal is to make the design simple rather than complex. Unnecessary elements reduce the efficiency of a design by forcing the user to think about which information to process first, rather than to intuitively understand what to do at once.

Occam's razor is applied to all concepts during the first iteration. Every page in the prototype is reviewed and all unnecessary information is eliminated. This is done to enhance the discoverability and make the signifiers more distinct. Some examples of the updates are visualised in figure 7.10 with check symbols for approved elements and crosses for disregarded ones.

The placement and presentation of information is evaluated during the cognitive walkthrough. If a user has impaired vision it is exhausting to search a page with a lot of information. The features that visually impaired individuals would search for should therefore be extra clear, like calling the reception. The reception is due to this insight moved up on the display to be easier to find. Less or simpler decisions make the interaction less exhausting. For repetitive visitors it is important that changes in the interface does not affect the users experience too much, or at all. Colours, symbols, sorting and placements should be consistent and recognisable, since this is what the repetitive user will be looking for. The interface should be both professional and casual to feel modern and encourage interaction. In the last usability studies, the updated symbols seemed to be clear to the users. These symbols are taken into the second iteration to be tested further.

Figure 7.10 Examples of the evaluation of prototype 1.

7.2.3.2 Evaluation of the search feature

"I don't want to scroll!"

Almost all of the participants in the tests and focus groups point out that they do not want to scroll. It is time consuming and irritating to not see what they are looking for directly on the display. When met by a long list the participants immediately start to look for a free text search function since that corresponds to their metal model.

"I want to write as little as possible"

Due to the lack of space for a standard keyboard layout many of the participants do not like the search feature where they have to write even if that is what their mental model makes them expect. It is time consuming and demand thought. The lack of the space to show suggestions for matching names also make people dislike the free-text search since it is not cooperating with their mental model of how it should operate. However, most of the test participants expected to be able to write the names. This creates a clash between what they want and what they expect. The free-text search feature and one of the versions where you begin by choosing the first letter is therefore chosen to be further developed in the second iteration.

7.2.3.3 Evaluation of the call feature

Occam's razor results in removing written words in the feedback, like calling and connected in the call feature. It is noted that only the change of colour as feedback in the call feature is not adequate since colourblind

people cannot always perceive the change. This is considered in the second iteration when colours are integrated in the interface. Another conclusion regarding the call feature is that the participants want to see themselves on the display as an indicator that they are being filmed, but not too large. They claim that a large view of themselves would be distracting.

7.2.3.4 Evaluation of new features

The small display size implicates limitations that are paid attention to. Decisions not to integrate new features such as maps or explaining animations are taken due to the lack of space and implicate impairment on the more central functions. Features that could be integrated without affecting the main functions are for example giving the user propositions of actions at unanswered calls, enabling extension numbers and simple text communication. Enabling extension numbers ensure the integrity of the employees, which is pointed out by several participants in the usability tests and discussions. Some participants had trouble finding the extension number feature, it is not clear if it is the same keypad as the one for personal digit codes for access or not.

Some tests include a message feature that enable the user to send a message from the door station. This is proven to be a confusing and non-satisfying feature since there are no possibility for a usable keyboard and pre-determined message options are too complex. It is decided that text messages should not be able to be sent from the door station, however messages sent to the door station as an option to answer a call is positively received and implemented. This leaves the problems for deaf and mute people unsolved. A new solution to that is enabling the camera on the door station to interpret sign language, but details and technique behind such feature is not further examined.

7.2.4 **Results of the first iteration**

The first iteration results in two new wireframe concepts, concept D and E. These two concepts form the foundation for prototypes in the second iteration. The evaluation of the variations of the features is also considered in the next iteration along with the feedback regarding making the start pages feel more welcoming. Another finding for the first iteration that is considered in the second iteration is the issues regarding the context of the door station.

- *Concept D.* This concept is a combination of concept A and B. The user starts the interaction by choosing who they are, but it also confirms to the user which address or building they are at. See figure 7.11.

Figure 7.11 Concept D.

- *Concept E.* This concept is an updated version of concept C, without call groups on the start page. See figure 7.12.

Figure 7.12 Concept E.

7.3 The second iteration

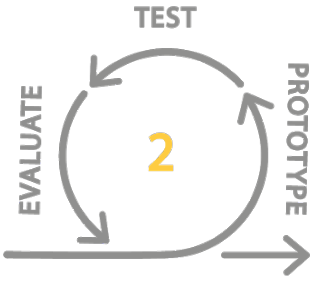


Figure 7.13 The second iteration.

The second iteration has the same stages as the first iteration, see figure 7.13. In the first iteration the impact of the external touch button on the UX is not acknowledged. The function and existence of the external touch

button is therefore explored in the second iteration. The secrecy of the product is gradually reduced during the second iteration, therefore the participants in the usability studies can gradually vary.

7.3.1 **The second prototype**

The second iteration is based on graphic lo-fi prototypes. These prototypes are constructed digitally in Adobe Illustrator and then printed on paper for the testing, see figure 7.14. The graphic style, colours and other layout details are integrated as well as the aspiration for a unitary design throughout the interaction flow. In the second iteration the start pages are updated with logos, symbols and texts such as Welcome to invite users to interaction. To help the participants of the usability tests grasp the context a cardboard model of the door station is constructed and presented along with the paper prototypes for the display, see figure 7.15.

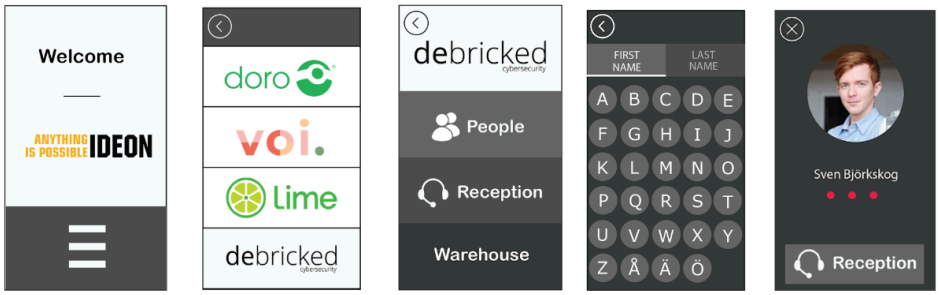


Figure 7.14 Examples of the pages in the second prototype.

Figure 7.15 Cardboard model of the door station.

7.3.1.1 External touch button

The presence of the external touch button is included in this iteration. At first it is added to the prototype with the function of calling a predefined call-group, according to decisions in the ongoing discussions at Axis. This turns out to be confusing and do not work well together with the rest of the interface. The buttons function, and existence, is therefore further explored. The aim is to see if there were any functions in the UI that can be taken out from the display to reduce confusion in the interaction flow.

7.3.1.2 Layout and graphic design

Since the display is small it is important with an efficient use of the space. To create a pleasurable UX the clickable areas should be easy to hit. According to Interaction design foundation (2019), Fitts' law declares that the amount of time required to move a pointer (finger) to a target area is a function of the distance to the target divided by the size of the target. Thus, the smaller the target's size, the longer it takes. The clickable areas in the second prototype are therefore designed as big as possible.

In this iteration there is a large focus on the use of symbols to make the UI independent of language. The first versions of the second prototype use only symbols to communicate its functions. The only text is the names in the name list and complementary information about opening hours etc. The goal is not to end up with a UI containing only symbols, but to enable testing and updating of the symbols without being affected by any complementing text to ensure that the symbols is enough if the user has language difficulties. The symbols are eventually complemented with or replaced by text.

One of the criteria in the functional analysis is that the UI should be perceived as modern. The result of the benchmarking on modern GUI design is applied to the symbols and other graphics in the layout. The relation between round and straight shapes is explored. The main focus in this thesis is not the graphic design, but the cognitive understanding. The graphics is therefore only briefly evaluated.

The fonts in the GUI are chosen to be easy to read and to fit the design. The font size is set to the biggest possible while still having room for longer titles and names to give the best legibility.

7.3.1.3 Keypad

The keypad receives little attention in the first iteration, but due to struggles with the feature of calling extension numbers it gets more attention in the second iteration. The struggles consisted of ways to signify if the keypad allows a personal digit code for access or a digit code for calls. Ways of providing clear signifiers and feedback in the two cases are explored, including variants with two separate keypad features or one feature containing both functions.

7.3.1.4 Search feature

In the first iteration two versions of search feature are chosen. These two variants are prototyped, further evaluated, elaborated and compared in this iteration.

7.3.1.5 Call feature

The focus in the second iteration regarding the call feature is to create different graphical versions of the best designs from the first iteration for further testing.

7.3.2 **Testing of the second prototype**

Figure 7.16 Tests in the second iteration.

The testing of the prototype proceeds with two of the methods used in the first iteration, single-user tests and focus groups (figure 7.16). An additional cognitive walkthrough with the personas is considered, but the needs of the personas are considered to be fulfilled after the first iteration. Single-user tests are the main testing method in the second iteration focusing on quantity rather than quality. The result from the qualitative usability studies in the first iteration gives a deeper understanding of the problems but needs to be complemented with quantitative data. Qualitative testing in focus groups and single-user tests with discussions are applied after major updates of the prototype. The main difference from the first iteration in the testing methods are that the number of alternative solutions is narrowed down and the discussions with the participants are shorter. A/B testing is applied for some features in the second iteration to the narrow down the alternative designs.

During the second iteration the secrecy level of the product is reduced which makes usability studies outside of Axis possible. Out of the 25 people that participates in the usability studies 15 of them are not Axis employees. The studies consist of two focus groups with two participants each, and the rest are single-user tests. An overview of the tests are shown

in table 7.2. The duration does not include preparation and evaluation of the tests. In this iteration a wider spread of both age and occupation are reached in the test group.

Table 7.2 Testing of the second prototype

Test method	*Number of tests*	*Number of participants*	*Duration (min)*
Single-user test	21	21	15
Focus group	2	4	60
Cognitive walkthrough	-	-	-
Total	23	25	435 (7,3h)

7.3.3 **The second evaluation**

7.3.3.1 Evaluation of the external touch button

The external touch button is confusing since it is static and separated from the rest of the interaction flow. It is difficult to put a function for visitors on this button since many of the test participants do not see or dare to click it. This is taken advantage of. There are two separate interaction flows for the door station, one for the visitors and one for the authorised users. One of the difficulties is to separate the interaction flows for the users and to clearly show who should use which features. Since the visitors do not intuitively click the external touch button and only feature that is needed for authorised users, a keypad for personal digit codes, is put on the button. The button is given a keypad symbol to make its function clear for users. This physical separation of the two interaction flows create less confusion for visitors, since the display is then only for them. The authorised users also benefit from this. Since the authorised users use the door station several times a day it is a quick and easy interaction. With a separate static button there is no risk that they have to look for their feature in the GUI if a previous user left the door station at another page than the start page. The risk of missing the target and opening the wrong feature on the display is also heavily reduced. This concept is a combination of concept D and concept E. The user indirectly chooses if they are a visitor or authorised user by choosing the area of interaction like in concept D. The layout on the other hand is the same as for concept E. They then only see the information and features meant for them. The authorised users with only a personal digit

code for identification is not a large group of users. The function meant for them is therefore “hidden” in a feature separated from the rest of the interface to not distract the other users.

It is difficult to motivate another use of the button than separating the interaction flows. For that reason, another concept without the button is created to make a comparison. The difficulties of separating the interaction flows for the users made it natural to focus on concept D for this concept. In this concept the users choose if they are a visitor or an employee on the start page to only show the features meant for them.

7.3.3.2 Evaluation of the layout and graphic design

There are no problems with the size of the clickable areas in the usability studies in the second iteration. This however needs to be tested with digital clickable prototypes to confirm.

After a few iterations with updating the symbols most of the test participants can interpret them. However, all the symbols are not clear enough to make the user feel sure of their meaning in all cases, but rather guess their meaning and function. This is due to the lack of appropriate established symbols in the context for some of the choices in the GUI. This leaves room for error and does not ensure a pleasurable UX. When the symbols are complemented with text however, their message become clear for the participants. Figure 7.17 displays the change from only using symbols to symbols and text combined. Combining several coding methods to present information improves the perceptibility, which is one of the characters of universal design. The conclusion of this is that the symbols should not be seen as an independent way of communication, but rather ensure the user it is the right choice and help them find what they are looking for. In terms of language difficulties, the symbols help in most cases if the user does not know the language at all, and if the user knows some of the language, they should be able to interpret the GUI.

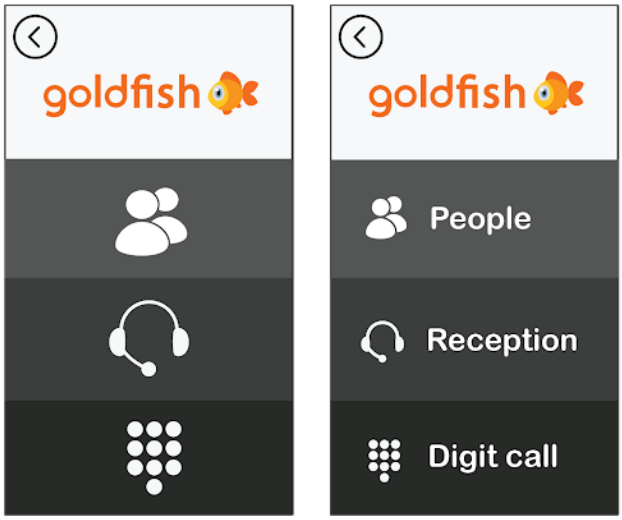


Figure 7.17 To the left, an interface only using symbols. To the right an updated version with text and symbols combined.

The legibility of the text in the second prototype is no problem for test participants with far sighted of 1.5 without using glasses.

7.3.3.3 Evaluation of the keypad

The problem with how the extension number feature should be integrated in the interface is solved in two different ways.

In the concept without the button it is an easy fix since the first choice on the display eliminates the need to show the keypad that is not meant for them. Two separate keypad features with different functions are designed and put in the two categories Visitor and Employee.

The concept with the button gives the user two ways of reaching the keypad. One way is through clicking the button and one way is to click the keypad alternative on the display. Just because most of the participants in the usability studies do not click the button it does not mean that no visitor will. This meant that the user needs to be able to use the extension number regardless of what way they reach the keypad. There could therefore only be one keypad feature that needs to handle both making a call and interpreting a personal digit code for access. Ways of designing an adaptable keypad is explored and ends up in a solution where the user do not choose what kind of code they want to use but let the door station interpret the digit code as an extension number or an access code. This

creates a limitation for the authorised users in their choice of a personal access code, since they cannot choose a digit code that is used as an extension number. The length of the code also needs to be the same for all personal digit codes and extension numbers.

7.3.3.4 Evaluation of the search feature

The free text search feature is evaluated and elaborated to fulfill the expectations and desires from the test participants. The feedback in the usability studies are however too differing and difficult to satisfy with the small size of the display. This result indicates that the display size should be increased, or another search feature should be applied. Since the display size cannot be changed, this feature is rejected as a fit solution. The search feature where the user choose one letter works better. It avoids the mental model that the participants perceive when met by a list. The list immediately gives the participants expectations of a free text search feature which is proven not to work satisfying enough. This search feature does not fully correspond to the test participants mental model, but most of the participants describes is as a positive experience even if the outcome is not what they expected. The UX of the feature is difficult to test with a lo-fi prototype and the Wizard of Oz method and is taken into the final iteration to test further.

7.3.3.5 Evaluation of the call feature

During the usability studies some functions are acknowledged as unnecessary and are therefore removed from the interface, for example the proposition to call again if there is no answer. Other updates that are applied to the prototype are the improvement of the feedback for which reception is being called, and the feedback for when a call gets no answer.

7.3.4 **Results of the second iteration**

The second iteration results in two final concepts that are prototyped and tested in the third iteration.

- *The Display only concept.* This is a concept where the external touch button is removed from the hardware and the display is the only area of user interaction. The basis of the concept is the same as concept D from the first iteration where the user starts the

interaction by choosing if they are a visitor or an employee, but more evolved. The start page also confirms to the visitors that they are at the right place. The start page for the concept is displayed in figure 7.18.

Figure 7.18 ***The Display only concept.***

- *The Button concept.* This concept is based on concept E from the first iteration, with the addition of the external touch button with a shortcut to the keypad. The button is provided with a keypad symbol and its purpose is to separate the use case for the authorised users from the use case for the visitors. The authorised users with a personal digit code for access do only interact with the external touch button leaving the entire display for the interaction of the visitors. The start page displays a list of company names with logos where the visitor can choose which company they are visiting, see figure 7.19.

Figure 7.19 ***The Button concept.***

7.4 The third iteration

The third and final iteration (figure 7.20) mainly focuses on evaluating the previously taken design decisions with hi-fi prototypes. To do this, experts at Axis that had been interviewed in previous stages of the thesis were invited to single-user tests and following short discussions. Quantitative usability studies are then held to confirm or contradict the design. The evaluation in this iteration consists of reflections and propositions for further development rather than updates of the design.

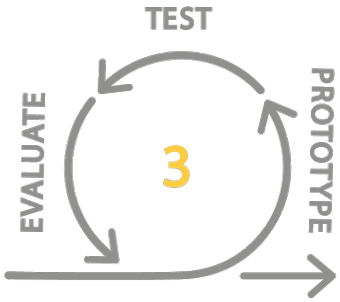


Figure 7.20 The third iteration.

7.4.1 **The third prototype**

The graphic design of the hi-fi prototypes is taken straight from the updated lo-fi prototypes in the second iteration. Two clickable digital hi-fi prototypes are created in the prototyping tool Adobe XD for the two chosen concepts, *The Display only concept* and *The Button concept*. *The Button concept* is prototyped with a render of the door station and tested using a tablet in 1:1 scale, see figure 7.21. For *the Display only concept* the Adobe XD prototype simply consists of a display. It is presented on a smartphone put into a case with the appearance of the door station, also in 1:1 scale, see figure 7.22.

Figure 7.21 Tablet prototype of *The Button concept* mounted on wall.

Figure 7.22 Smartphone prototype of *the Display only concept* in cardboard case mounted on wall.

7.4.2 **Testing of the third prototype**

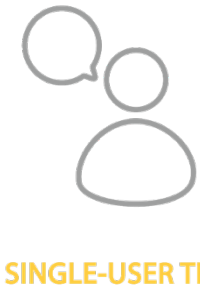


Figure 7.23 Test method in the third iteration.

The testing in the third iteration consists of 62 single-user tests (figure 7.23). An overview of the tests in the third iteration can be seen in table 7.3. The duration does not include preparation and evaluation of the tests. Seven of the test participants in the final iteration are experts in the product or an area affecting the product at Axis. The experts for example consist of tech writers, UX designers and programmers. These tests are followed by a short discussion. 27 single-user A/B tests are held with a varied group of people regarding age and gender outside of Axis with short or no discussion afterwards. In these tests the prototypes are held in front of the test participants. The last tests are held in an informal usability study with A/B testing outside of the main reception at Axis, just like the tests in the Discover. Results from these tests are gathered by observation and written notes. The prototypes are mounted on a portable wall in these tests. The participants in this usability study are 28 Axis employees in ages ranging from 25-50 years old, mostly men.

Table 7.3 Testing of the third prototype

Test method	*Number of tests*	*Number of participants*	*Duration (min)*
Single-user test	62	62	5
Focus group	-	-	-
Cognitive walkthrough	-	-	-
Total	62	62	310 (5,2h)

7.4.3 **The third evaluation**

Since the concepts in the third iteration are already tested with lo-fi prototypes in the second iteration, details such as signifiers, feedback and mapping played a significant role in this evaluation.

7.4.3.1 Evaluation of the layout

In this final clickable hi-fi prototype actions are taken to make the design and interaction flow consistent. Previously the use of crosses and arrows to communicate the return option is inconsistent. In the updated prototype an arrow takes you back to the previous page while a cross takes you straight back to the start page. This improves the mapping which helps the users to orient in the interaction flow.

The usability studies show that the size of the clickable areas are not too small for neither sight nor touch. The prototypes are made in scale 1:1 and placed on a wall, but still there are no issues regarding visibility or hitting the target. The touch displays used for the prototypes are more advanced than the one on the door station, but since no scrolling and swiping is required in the concepts there should not be an issue applying the UI to the actual product.

"Am I a visitor or am I looking for an employee?"

In *The Display only concept* there is some confusion regarding the start page. The participants have different perceptions of whether the choice between visitor and employee are aiming at themselves or the person they are visiting. The perception that it is aiming at the person they are visiting more commonly occurred during usability studies with participants from Asia, which implies cultural differences. The visitor/employee options are therefore complemented with text saying I am a visitor and I am an employee, see figure 7.24.

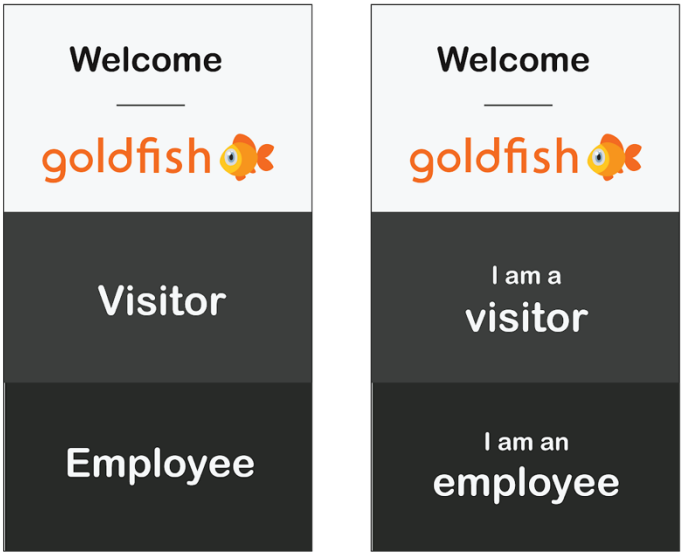


Figure 7.24 Update of the start page for The Display only concept. The old one to the left and the new design to the right.

7.4.3.2 Evaluation of the search feature

The search feature with the choice of the first letter of the name works satisfying enough in the final usability study in its right habitat and context.

"It was a positive surprise when the names turned up already at the first letter."

7.4.3.3 Evaluation of the call feature

The design of the volume control in the calling feature is explored in this iteration. Focus is on the appearance of its signifiers, feedback and placement. It will probably not be a commonly used feature and therefore it should have a low impact on the design. The conclusion from the usability studies is that the volume control should open when clicking a speaker symbol and have buttons for raising and lowering the volume instead of a slider. After a call ends the volume goes back to a default setting. Out of the tested and evaluated design suggestions the winner is the one in figure 7.25.

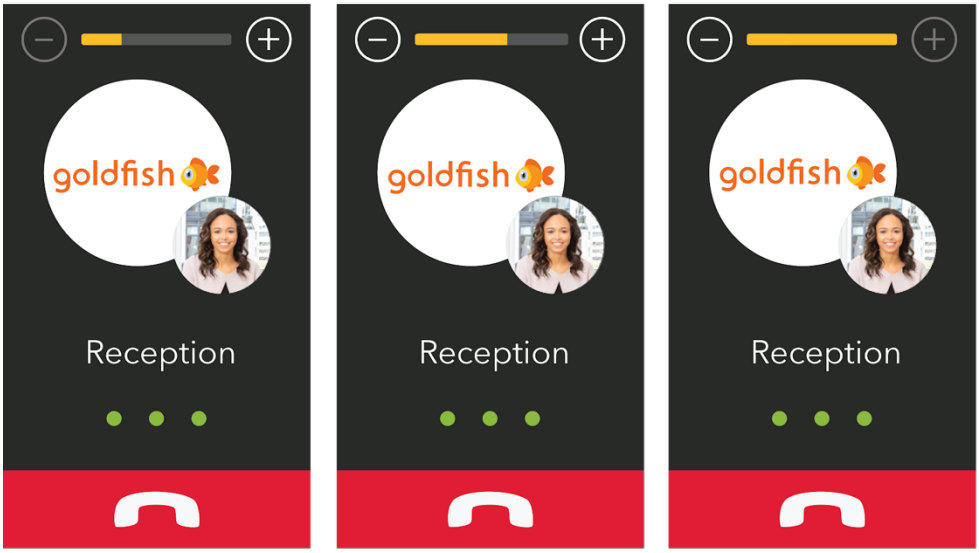


Figure 7.25 Volume control.

The usability studies show that the feedback in the call feature when a call is disconnected is not clear enough. The red symbol for a disconnected call is therefore complemented with text feedback, see figure 7.26.

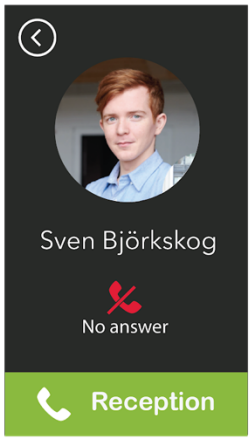


Figure 7.26 Disconnected call

In an attempt to avoid misdialing a confirmation page is added in the call feature, see figure 7.27. The confirmation page is then removed after the usability studies since it confused the participants and was perceived as unnecessary.

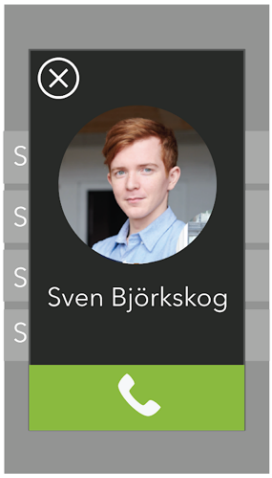


Figure 7.27 Confirmation page

7.4.3.4 Evaluation of the keypad

In the same way as in the second iteration the keypad is handled differently in the two concepts. *The Button concept* requires an adaptive keypad that accepts both extension numbers and personal digit access codes. To enable authorised users to freely choose any personal access code they like and to enable visitors to see the digits they are entering a new concept for the keypad is developed in this iteration. In the new concept all extension numbers started with a star (*). The function of the star is to signal to the system that it is an extension number and then the keypad will adapt to an extension call mode. During the usability studies there are some confusion whether the star is part of the extension or not. The star (*) and the hashtag (#) are therefore exchanged to an A and a B on the keypad, see figure 7.28. All extensions in the final concept starts with an A.

In *The Display only concept* the two keypad modes for handling extension numbers and personal digit access codes are placed in different interaction flows instead of making the keypad adaptable.

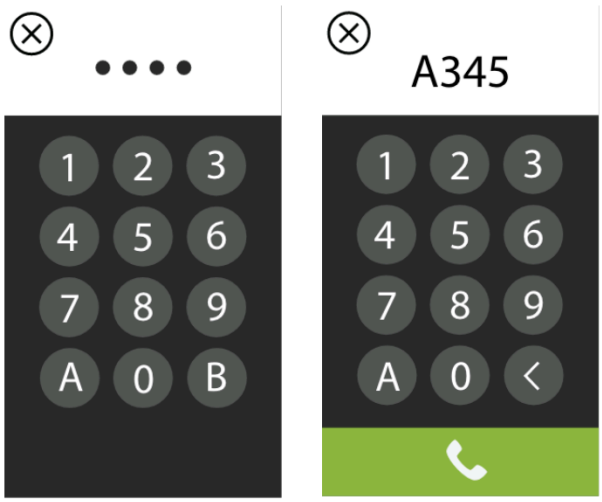


Figure 7.28 Adapting keypad for *The Button concept.*

7.4.4 **Results of the third iteration**

The result of the usability studies in the third iteration was satisfying enough. The third iteration therefore results in two evolved versions of *The Display only concept* and *The Button concept*. The resulting design of the third iteration is presented in chapter *8. Deliver.* Most of the feedback regarding the features are applied to the final prototypes, but there is still room for further improvements which is analysed in chapter *9. Discussion.*

7.5 Summation of tests in Develop

A summation of the total amount of tests performed during the three iterations can be seen in table 7.4. The duration does not include preparation and evaluation of the tests. The final deliveries are based on the results from these tests.

Table 7.4 Total testing of the three prototypes

Test method	*Number of tests*	*Number of participants*	*Duration (min)*
Single-user test	87	87	5-45
Focus group	4	10	60
Cognitive walkthrough	4	-	-
Total	10	97	1125 (18,8h)

8 Deliver

In the final phase of the thesis (figure 8.1) the solutions are delivered with two digital hi-fi prototypes. The final concepts are presented and explained in visualisations of their interaction flows. The visualisations specifies the structure and the features of the UI, which actions can be taken and where the UI should be complemented with audio feedback.

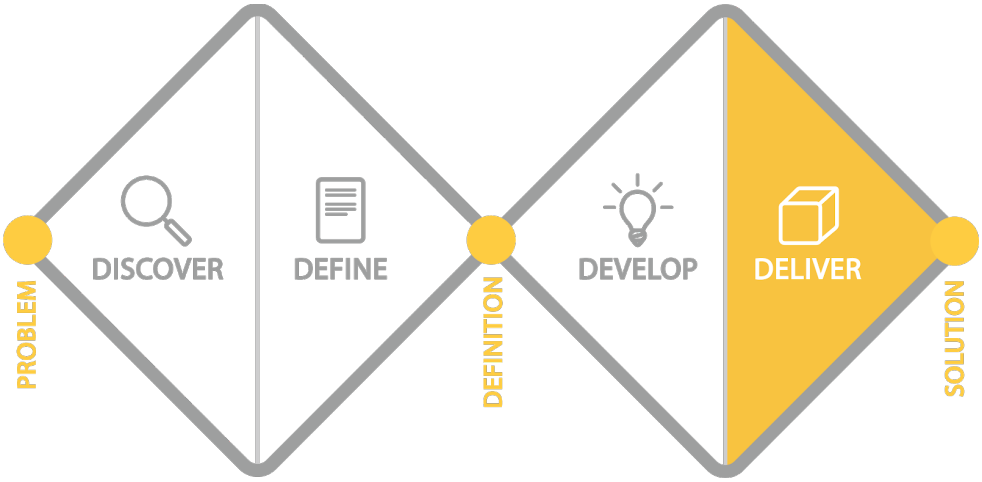


Figure 8.1 Deliver in the Double diamond process. In Deliver the concept or concepts are finalised and presented.

8.1 Visualisations

The prototypes and visualisations address scenarios where the door station is placed outside of buildings housing several companies. The authorised users are assumed to use a single identification system with personal digit codes for access. The codes are assumed to have the length of four digits but could in reality have any length. The letters A and B are considered

being digits and can be included in personal digit codes. In the two concepts there are no restrictions for how many call-groups that can be added, and the option to enable extension numbers can be made for each company page. A symbol for sign-language interpretation is included in the UI as two hands in the upper left corner in the call feature. This feature is not furthered developed and is therefore not visualised.

The audio feedback is displayed with a speaker symbol (figure 8.2) in the visualisations of the interaction flows.

Figure 8.2 Symbol indicating where the UI should be complemented with audio feedback in the visualisations if the interaction flows.

In the visualisations of the interaction flows an arrow (see figure 8.3) between each page indicates a change of the displayed information on the display. Text and symbols accompanying the arrow indicates that the change is caused by the user clicking the mentioned option.

Figure 8.3 Arrow indicating a change of the displayed information on the display in the visualisations of the interaction flow.

The parts of the interaction flow visualised in section *8.1.2 The Button concept* are the parts that differ from the visualisations in *8.1.1 The Display only concept*. The search feature, the call feature and the company pages are the same for the two concepts. The visualisations only show the display and the external touch button. The design of the whole solutions can be seen in figure 8.4.

Figure 8.4 The design of the whole solutions with the start pages of the final concepts. *The Display only* concept is on the left and *The Button concept* is on the right.

8.1.1 **The Display only concept**

The Display only concept is a concept where the external touch button is removed from the hardware and the display is the only area for user interaction. The basis of the concept is that the user starts the interaction by choosing if they are a visitor or an employee. The address or the name of the building is displayed on the start page, in this visualisation the name of the building. *The Display only concept* is visualised in figure 8.5-8.10.

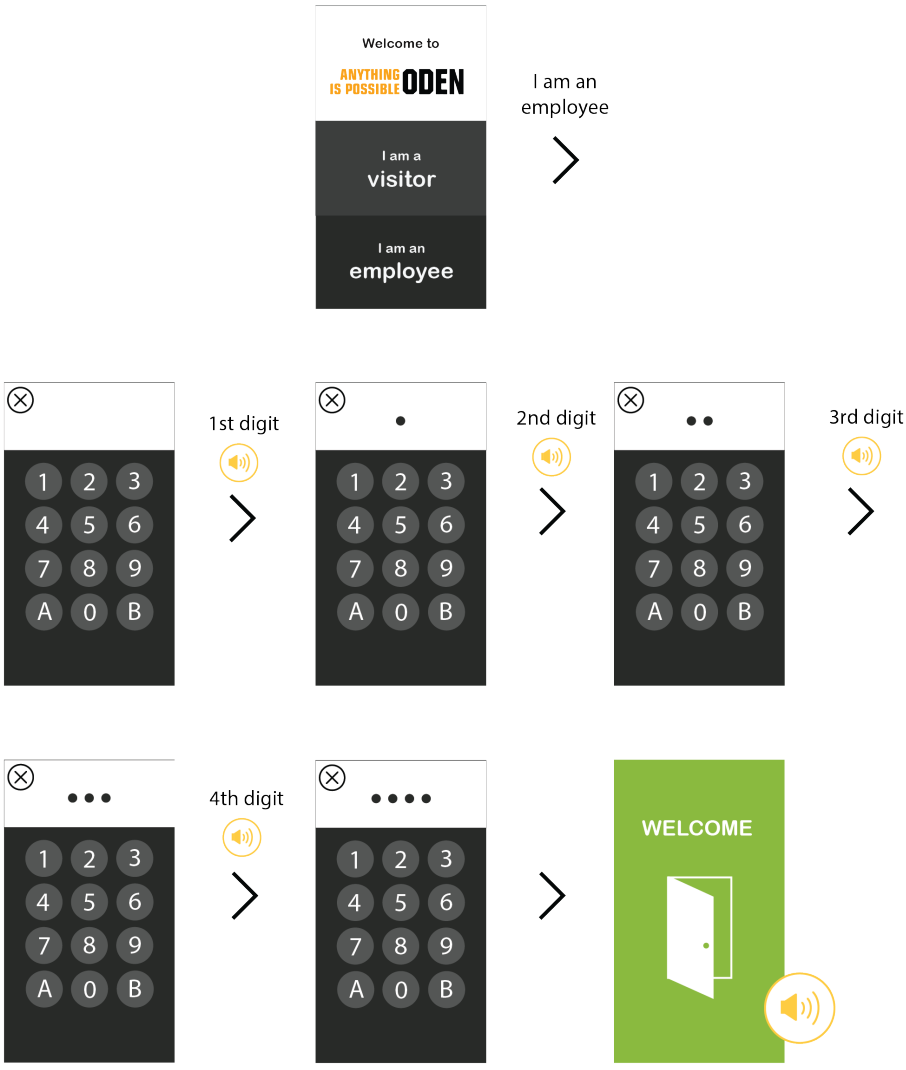


Figure 8.4 The interaction flow for authorised users in The Display only concept.

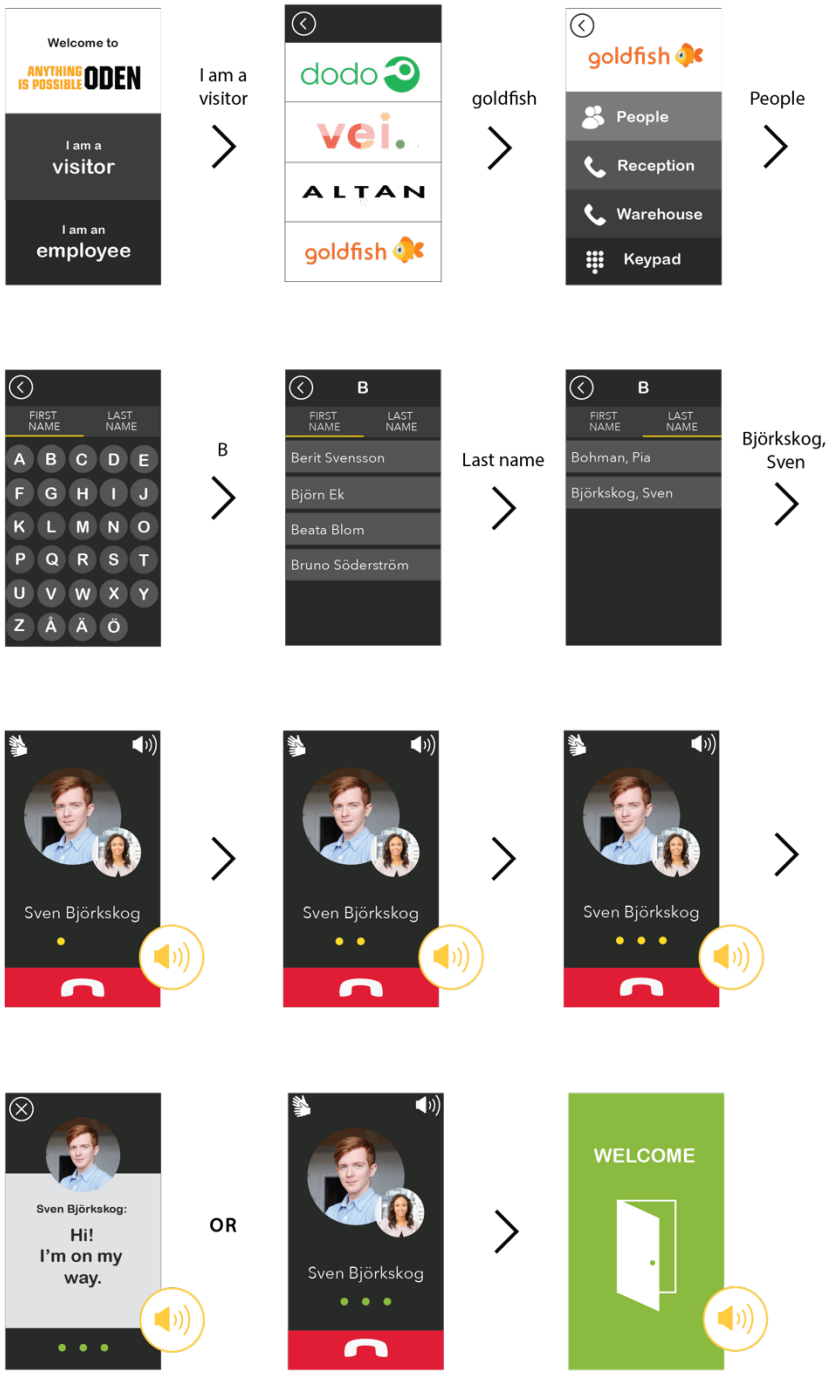


Figure 8.5 The interaction flow for a visitor who wants to call a specific person using a name list. There are two options for how the receiver of the call wishes to answer, by a message or speaking to the caller.

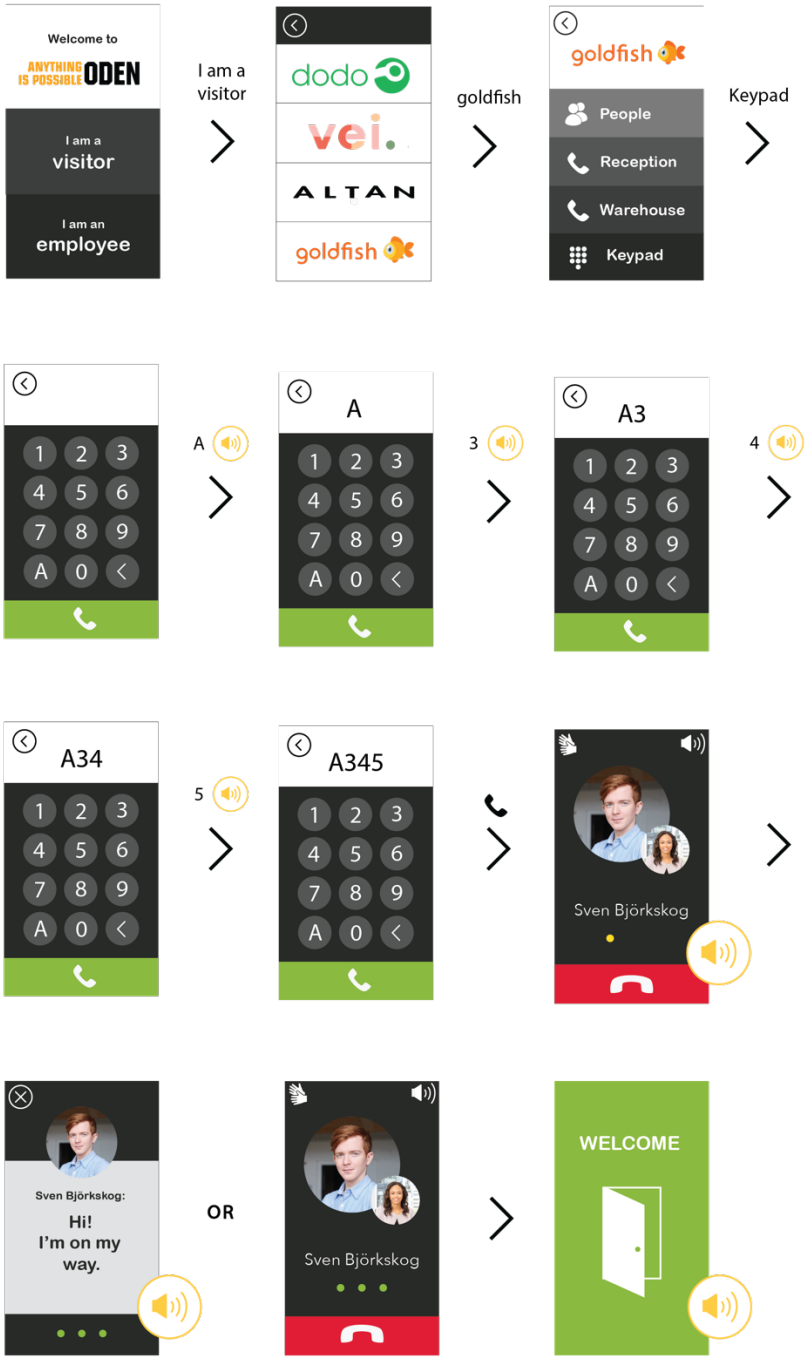


Figure 8.6 The interaction flow for a visitor who wants to call a specific person using an extension number. There are two options for how the receiver of the call wishes to answer, by a message or speaking to the caller.

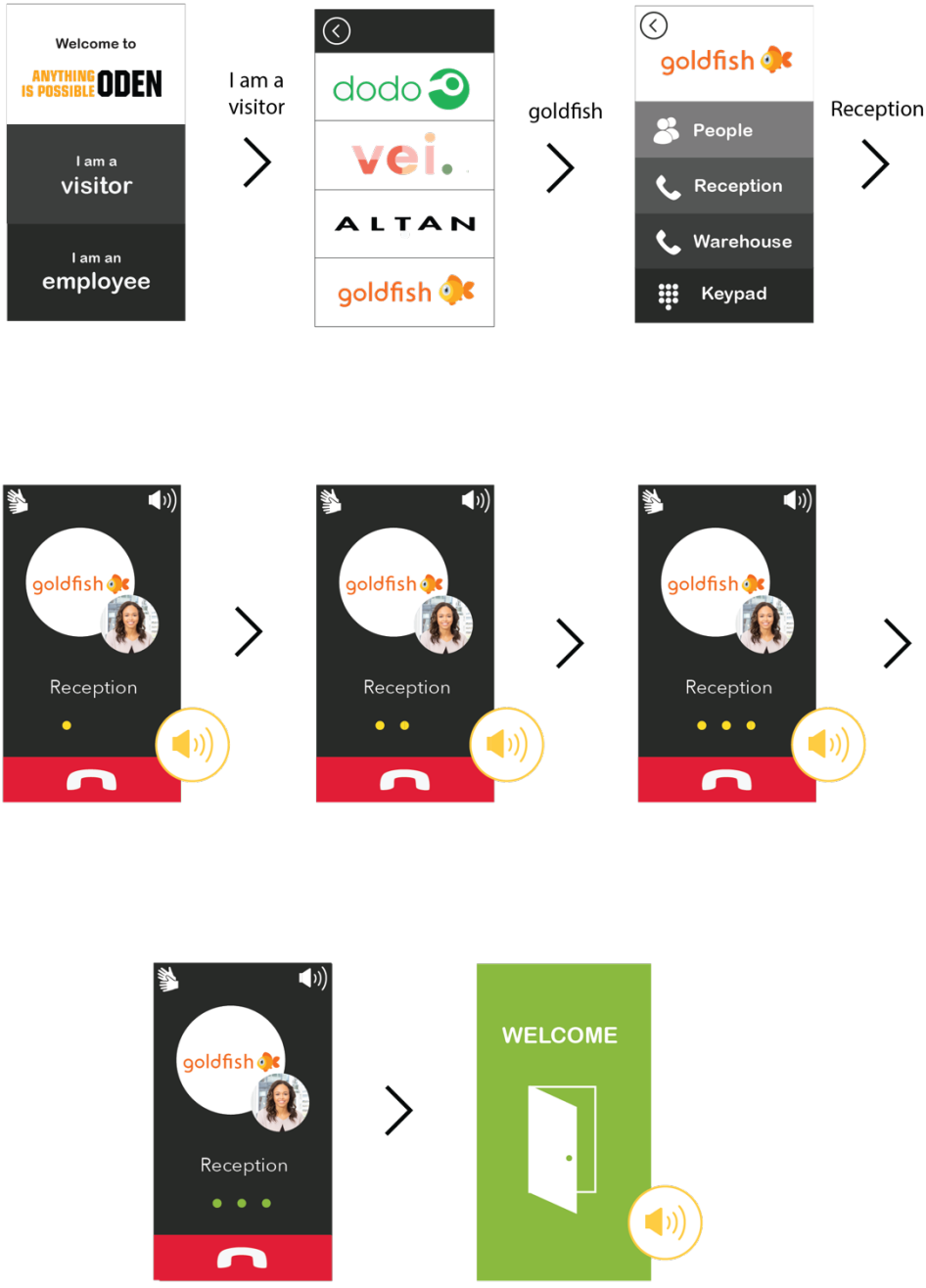


Figure 8.7 The interaction flow for a visitor who wants to call the reception. The reception is added in the company page as a call-group.

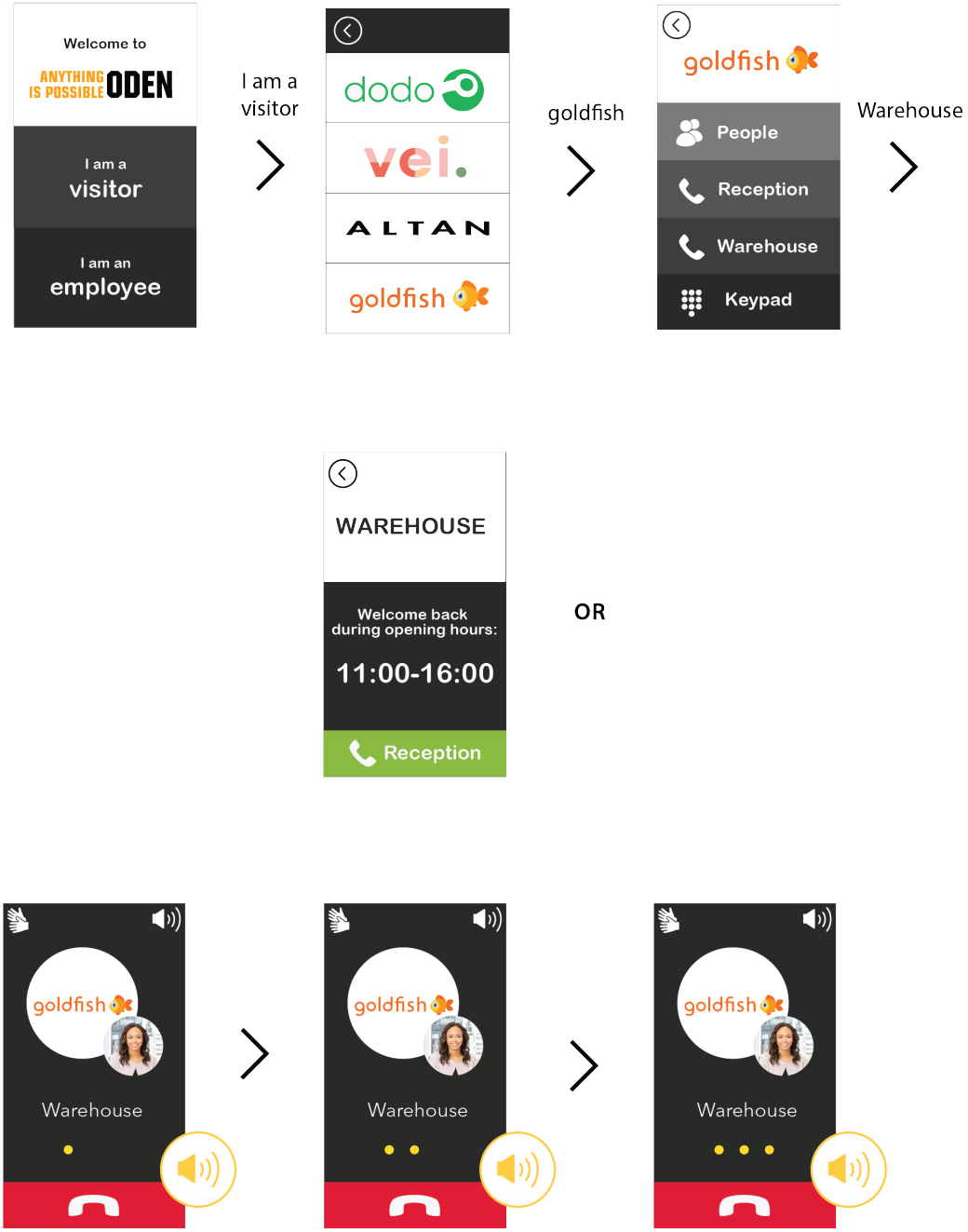


Figure 8.8 The interaction flow for a visitor who wants to call a call-group other than the reception, in this case the department Warehouse.

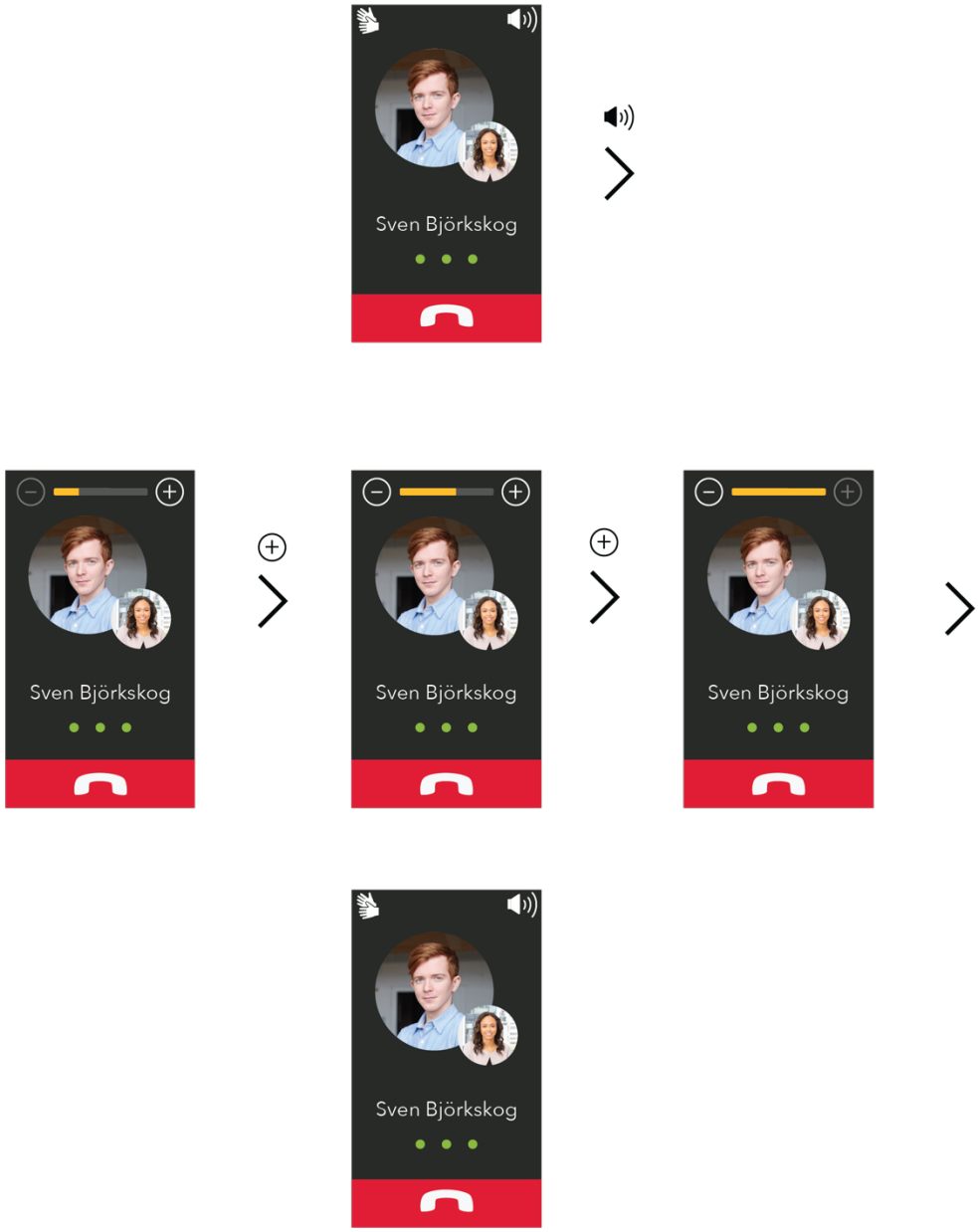


Figure 8.9 Visualisation of the volume control in call. The volume can be controlled by clicking the speaker symbol in the upper right corner of the display. A volume control panel then shows up and lets the user increase or decrease the volume by clicking + or -.

8.1.2 **The Button concept**

In *The Button concept* the external touch button is a part of the hardware and the UI. The button is marked with a keypad symbol and its purpose is to separate the interaction flow of the authorised users from the interaction flow of the visitors. Authorised users with a personal digit code for access do only interact with the external touch button leaving the entire display to the interaction of the visitors. The start page in this concept displays a list of company names with logos where the visitor can choose which company they are visiting directly, instead of choosing if they are a visitor or an employee first. The other main difference is how the keypad is reached. There is always the option of reaching the keypad using the external touch button, regardless of where the user is in the interaction flow. The keypad can also be reached by clicking the Keypad option within each company, like in *The Display only concept*. Nothing tells the user if the external touch button is for authorised users or visitors, or in other words if the keypad reached by clicking the button can interpret personal digit codes or extension numbers. Therefore, is has to be able to do both and adapts its interface after which type of code is entered. However, the keypad reached with the Keypad option within each company only interprets extension numbers.

In the adaptable keypad, the first digit of the code indicates to the device if the code should be interpreted as a personal digit code for access or an extension number. Extension numbers starts with A and personal digit codes starts with any digit except for A. For that reason, a restriction for the personal digit codes in *The Button concept* is that they cannot start with A, since the device would then interpret the code as an extension number.

The features in *The Button* concept that differs from *The Display only concept* is visualised in figure 8.10-8.12.

Figure 8.10 The interaction flow for authorised users in The Button concept.

Figure 8.11 Interaction flow for calling an extension number using the adaptable keypad opened with the external touch button.

Figure 8.12 Interaction flow for calling an extension number using the keypad opened with the Keypad option on the company page.

8.2 Recommendation

The best and most suitable concept depends on the context and for that reason a recommendation is formed to fit four different use cases. The two delivered concepts are combined and adjusted to be optimised for the following four use cases.

- *Building housing several companies, single identification system with personal digit codes.* The recommendation for this use case is *The Button concept*. The keypad function on the external touch button frees space on the display in an effective way, and lets the GUI be adapted fully to the visitors. The start page for the concept is displayed in figure 8.13.

Figure 8.13 Recommendation for building housing several companies, single identification system with personal digit codes.

- *Building housing several companies, double identification system or single identification system without personal digit codes.* The recommendation for this use case is a modified version of *The Display only concept*, but with a start page with the listed companies directly instead of the I am a visitor/I am an employee option. In this case the keypad does not need to be available from the start page for neither the authorised users or the visitors, and therefore only takes up valuable space and attention. The start page for the concept is displayed in figure 8.14.

Figure 8.14 Recommendation for building housing several companies, double identification system or single identification system without personal digit codes.

- *Building housing one company, single identification system with personal digit codes.* The recommendation for this use case is *The Display only concept*. In this use case the usability studies showed that the external touch button would rather contribute to confusion than support. The start page for the concept is displayed in figure 8.15.

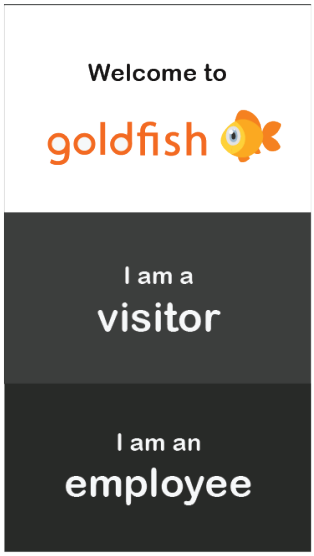


Figure 8.15 Recommendation for building housing one company, single identification system with personal digit codes.

- *Building housing one company, double identification system or single identification system without personal digit codes.* The recommendation for this use case is a modified version of *The Display only concept*, but without the first page with the I am a visitor/I am an employee option. The text "Welcome to" is also added to the logo at the top. The start page for the concept is displayed in figure 8.16.

Figure 8.16 Recommendation for building housing one company, double identification system or single identification system without personal digit codes.

8.3 Future improvements

The aesthetics of the GUI was not a main focus in the thesis and therefore has large potential for improvement. For example, the clickable areas in the GUI could be modernised by removing their varying backgrounds to a unitary color, see figure 8.17. The clickable areas could also have less of a classic button design and just be detached texts and symbols with thin delimiters to mark the clickable areas instead.

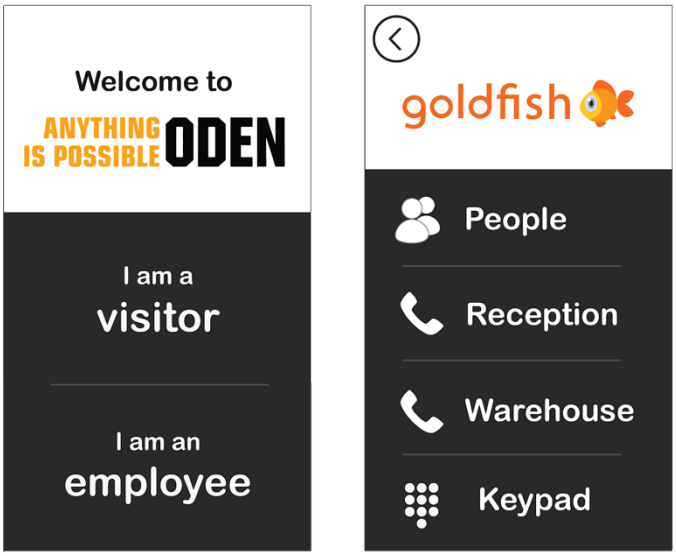


Figure 8.137 A modernised design suggestion.

The first page for *The Display only concept* could also be updated with symbols to communicate the meaning of I am a visitor and I am an employee. This would improve the perceptibility. The solution as it is, is depending on language comprehension which should be eliminated. The reason for not complementing with symbols was the lack of time to investigate proper symbols to represent the options meanings.

The following part of the suggestions for future improvements concerns the UX and universal design not directly related to the GUI and are beyond the delimitations of this thesis. Focus is put on operability.

One of the observations in the usability tests were that the thickness of the glass made it difficult for users to hit target areas of the display close to the edges of it. Since there was no physical feedback of if the finger hit the glass in the area of the display or not, they did not discover the problem and got confused. This could be fixed by adding some kind of tactile or visual signifier or feedback that tells the user where the clickable area ends. Examples of this could be a printed visual line on the glass or a tactile cut or groove in the glass.

To make the UI better adapted to universal design, it should be possible to use for blind people. This is currently not possible since the interaction is depending of touch display technology with flat surfaces. The product

should in the future include some kind of use of braille text in combination with mechanic buttons or audio.

Deaf or mute users have trouble communicating using the door station. The possibilities for a call feature that enables sign language interpretation could be further investigated. It had only been noted that the technology for this was during development during the time of the thesis, but not how close it was to being implemented for use.

People who uses hand prostheses are unable to interact with the door station if the interaction fully depends on touch display technology. Arthritis, rheumatism and other medical conditions that limits the mobility and precision in the hands can cause difficulties in the use of a touch display. In cold weather users with gloves or cold hands also experience struggles with the interaction of a touch display. To help these users, aid could be offered for example by having a touch pen attached to the door station.

The mounting of the door station also affects the UX. People of different heights will have different experiences with the interaction. The thickness of the glass affects the precision of hitting the targets of the display if seen from the side. This means that extra tall users, extra short users and users in wheelchairs will experience more struggles in hitting targets on the display. This could be solved with making the product or mounting of the product tiltable. An example of the application of this way to improve the UX is the standard mounting of card terminals at supermarket. They are often mounted with an adjustable fixture to help the users see the display and enter their pin correctly.

9 Discussion

The process, methods and results of the thesis are discussed in this chapter.

9.1 Conditions for the thesis

The original idea behind the thesis was to update an already existing version of the Axis Door Station with an established UI. That was the plan during the early stages of the thesis, but since decisions at Axis regarding the design delayed the launching of the product, the plan had to change. For that reason, the main task and the desired outcome of the thesis was difficult to establish. Since there was no finalised UI to relate to, the decision was made to develop a UI from scratch. This was done in parallel with the UX designers at Axis, but without any insights to their progress or outcome. The issue regarding the main task delayed the progress of the thesis work and affected the choice of used methods since the possibility of evaluating an already existing UI was very slim. For example, only one usability study was executed for the current prototype.

The delay of the launching affected the secrecy of the product as well, which prevented usability studies outside of Axis during the first and part of the second iteration in Develop. That lead to a narrow variation within the test groups in the early usability studies. A broader and more varied test group might have given a more profound feedback. The technical background of the participants at Axis might have angled the results in favor of the design. The later performed usability studies outside of Axis gave a lot of new and interesting insights. It was very enlightening to observe how individuals past the age of 60, with a non-technical profession or with an international background handled the presented scenarios in the usability studies. To get those insights earlier in the process would have been valuable for the progress of the thesis.

The inconsistency of the decisions regarding the function of the external touch button at Axis made it difficult to know how the development in the thesis should handle it. For that reason, the decision was made to ignore the decisions regarding the external touch button at Axis and define its use in the thesis in combination with the development of the GUI.

The condition of the already established hardware and technology of the door station prevented a fully human-centered design process. Due to some lacking fundamental aspects of ergonomics in the hardware, the UI in some ways had to focus more on fixing existing problems rather than inventing and developing smart and helpful solutions from scratch. The small size of the touch display and its technical limitations such as the inability of a functional scroll feature are issues that have been handled in the thesis. There are other technical hardware issues that has been considered but chosen to set aside and assumed not to exist in the final product to enable a UX design process for the UI.

9.2 Process

The two process methods applied in this thesis, human-centered design and the double diamond process, worked well together as expected. Since the main focus of the thesis was UX, the human-centered design approach was a necessary method. However, the method alone would have been too abstract for a thesis with a time limit. It would also have been difficult to set delimitations in the time frame since it would be difficult to divide the time into distinct blocks. Neither would the double diamond process alone have been appropriate. The double diamond process describes the structure of a creative design process but gives no support specifically to UX design. The process gives no assurance that the deliverables are adapted to human behavior or needs, which is the main focus in this thesis. The conclusion is that the methods for the process complemented each other and assured that the thesis had the right focus and covered all the relevant phases of a design process in the given time frame.

9.3 Method and results

9.3.1 **Discover**

9.3.1.1 The current prototype

Since the current prototype sets the physical and technical limitations of the product and the UI, the investigation of it was a necessary part of Discover. Examining the shape, size and components of the prototype gave a good understanding of the possibilities and limitations of the product as a whole. Examining the UI by trying it out, exploring the features and functions of it and discussing it with Axis staff created a foundation for the understanding of the purpose of the door station and what it should be able to do. This way of examining the prototype was a good way of getting introduced to the product and what the thesis is based on, but it did not give a deep enough understanding of the user scenario and the users for a UX focused product development process. This became extra clear after the A/B testing of the prototype where two different search features were compared. The test gave an understanding of the current design's propositions, but more importantly it gave an opportunity to study and talk to users. Since the product was not yet launched during the time of the thesis, it was a way to gain insight to how users interact with the product and how the technique helps and constrains them. Important to note is that this test did not fully correspond to the real context of the use, since the prototype was not mounted in connection to a door, no calls were connected to real people, the test took place indoors and the users did not have to discover and initiate the interaction with the door station by themselves. A more realistic test would have been to place the prototype in connection to an entrance to a commercial real estate or social property, simulate its connection to the door and have someone answering the calls. A test like that is however time consuming, costly, more complicated and did not fit the timeframe and possibilities of the thesis.

The test of the current prototype only takes into account the experiences of the visitors and not of the authorized users. Testing the scenario of the authorized users would require testing over a longer time period and repetitively with the same participants to cover pain points that are exposed only after repeated use. Neither was a test of such character possible during the thesis.

Since the participants of the test were mostly Axis employees it can be assumed that most of them were used to Axis products and technology in general. Some of the participants might even have seen an earlier version of the prototype before the test, which would make them coloured by the previous experience. The group of test participants can due to this not be treated as if they correspond statistically to a group of real users, who would be more diverse. The test results should therefore be treated the same way. The average user would probably struggle a bit more than the average participant of the test but may also have different expectations of the product. The test results would correspond better to reality if the test were held in a public place with randomly picked people, but due to the secrecy of the product this was not possible in this early stage of the thesis.

9.3.1.2 Interviews at Axis

The interviews with Axis employees was a natural next step in Discover to understand in which context the door station will be used and who and why someone would buy the product. The interviews helped set the delimitations and goal for the thesis as well as which functions it should and could enable. Since this thesis focuses on human-centered design the most important part of the interviews was identifying the users and their context. Getting information about the users indirectly like this is however a risky way of getting to know the users. There is a risk that the information in the interviews might not depict the whole picture of the situations the users are in. Ways of gaining more insight to the users and their context would be interviewing Axis' end customers and observing the environment and the people working at and visiting the end customers. This was not possible during the period of the thesis.

9.3.1.3 Benchmarking

A big part of the benchmarking consisted of studying modern GUIs. The method of studying GUIs were observing them and looking for patterns regarding the design, layout and mapping. The studies were performed in the context that seemed mostly relevant for a door station. The methods used for this part of the benchmarking suited the area of investigation. However, the benchmarking of similar products on the market could have been done more thoroughly to find similar products that could be seen and tried out in reality. This could have enabled observations of the use of

similar products in a realistic context to complement the test of the current prototype.

9.3.1.4 Metaphor

The metaphor of a reception was investigated through the use of a questionnaire sent out through email. This was an effective way of getting answers since it was not time consuming for either the thesis or the participants. It was also an easy way to get statistics since the answers were automatically put into diagrams and lists of statements. This made it easy to get an overview of the results. However, the result indicated that participants were more inclined to answer the questions that were closed more properly than the open ones. This could be assumed since the open questions got short and not very elaborated answers. As a complement to this some short interviews of receptionists focusing on open questions could have been useful. In a physical or phone interview the participants might have been keener to elaborate the answers to open questions. An option that would not increase the workload significantly could have been to replace the open questions with asking the participant for their permission to be contacted for a short interview on the subject. A conclusion from this study is that questionnaires are more fit to gather quantitative data than qualitative data.

9.3.2 **Define**

9.3.2.1 Purpose

Defining the thesis purpose was challenging due to the many changes in the conditions for the thesis. The uncertainty of the purpose slowed down the work in the thesis since the conditions several times had to be redefined. As a result of the changing conditions and the predetermined technology, the final purpose of the thesis became to investigate how to design a UI for an Axis Door Station with predetermined technology and to explore how the late implementation of human-centered design in the design process affected the methods and the process.

9.3.2.2 Functional analysis

- ***MF*** *- Allow identification to grant access.* This main function was fulfilled. The UIs developed are not dependent of the identification method and allows both single and double identification including

personal digit codes. No problems in this feature has been discovered, but it has also been difficult to test without a proper test context.

- ***MF*** - *Call person*. This main function was fulfilled. The final UIs enables users to call people using a name list, knowing the first, last or full name of the person, as well as with an extension number. The features developed for this function had satisfying results in the final tests.

- ***MF*** - *Call call-group.* This main function was fulfilled. The final UIs does not have a limit to the possible number of call-groups and all the call-groups are placed in the same place to be easy to find. This turned out to create less confusion than in the initial design.

- ***N*** - *Indicate safety*. This is considered in the graphic style and tone of voice of the GUI. The extension-number feature also provides safety regarding the integrity of the employees. It seemed to turn out during the process that it was more important that the UI was perceived as serious in general than specifically indicating safety. The physical design of the product itself already shows that it is a safety product.

- ***N*** - *Offer legibility*. The legibility was enhanced with a minimal amount of text and a maximised font size. The usability studies showed that farsighted people of level 1.5 had no problem with the legibility. This was considered good enough since farsighted people with a higher level than 1.5 probably use glasses.

- ***N*** - *Invite to interaction*. During the thesis it was proven that the first page the user encounters sets the tone for the rest of the UX. It became clear that it was more important that the UI invites to interaction in a clear and encouraging way than the interaction itself being fun. The first page of the interaction flow was therefore paid extra attention to during the Develop. Logos, symbols and the word “welcome” were received positively by the test participants and are a part of the final UIs.

- ***D*** - *Call extension number*. This function was integrated in the UI in a clear way without confusing or interrupting the users who does not wish to use it.

- ***D*** - *Adjust sorting*. The possibility to adjust the sorting in the name list got considered being especially desired since both results from the questionnaire and results in the usability studies showed that it is common to only remember the first or last name of the person they want to contact. Adjusting the sorting is then a way to help the user finding the name without having to think twice. This function is in both the final UIs.

- ***D*** - *Send message/notification*. The idea of being able to send messages from the door station turned out to be a too complex and unnecessary feature in the usability studies and was therefore discarded.

- ***D*** - *Receive message/notification*. The original idea of receiving messages/notifications were in the form of a reply to a sent message/notification. That idea was discarded but the idea of receiving message evolved into an option to answering a call for the person on the inside. The idea of this function was to create a better UX in a scenario where the receiver of the call is not able to answer it. If the receiver can send a message to the door station instead, the user is given a confirmation that the one they are trying to reach knows that they are there and is coming for them.

- ***D*** - *Perceived as modern*. To help achieving a modern perception of the GUI a brief benchmarking was performed even though the graphic design was not a main focus of the thesis. Therefore, there is still more potential for improvement regarding the graphic design.

9.3.2.3 Graphic style and tone of voice

The use of the diagram (figure 6.2) was an effective method to establish the graphic style and the tone of voice for the GUI. To visually display different GUI designs in relation to the scaled axes eased the otherwise abstract discussions with the employees at Axis involved with the door

station. The diagram concretised different design aspects which enables a clearer and less complex conversation. The meetings with the graphic UI/UX designer and terminology and tonality specialist were especially valuable for this part of the process and gave feedback to the GUIs in a late stage of the process to confirm that the desired outcome had been achieved.

The graphic style of the GUI was not a main focus of the thesis. However, it is something that should have gotten more attention in the process since Axis does not have any guidelines for this type of GUI. It would have been helpful and more efficient to establish examples as references for the graphic style before entering Develop. The graphic style has a lot of potential for further refinement.

9.3.2.4 Users

One major limitation in the UX design process was the lack of access to end users. The needs of the users have therefore been established through second-hand information from product owners and product specialists. Direct contact with the end users or the end customer in the beginning of the process would have affected the forming of the functional analysis which in turn would have affected the choice of included features for the UI.

The personas were created due to the lack of access to end users and the limited possibility of performing usability tests outside of Axis. The personas were created to enable simulating a broader test group than what was available. The forming and use of the personas would also have looked different with access to end users, and maybe even another method would have been chosen to assure the application of universal design.

9.3.2.5 Delimitations

The delimitations of the thesis were set gradually along with the evolvement of the thesis work. Most of the delimitations were set due to a limited time frame. The audio feedback connected to the UI for example would have been an interesting sidetrack to investigate. In the beginning of the thesis it was also considered to investigate the identification method in a double identification system in terms of AI and image recognition. The decision to discard these topics was essential to be able to go forward in the process.

9.3.3 **Develop**

9.3.3.1 Structure and iterations

The structure with three iterations based on prototypes with increasing complexity facilitated planning the work in *Develop*. It made it easy to set time limits for the iterations and it helped in deciding which parameters that could be disregarded in each iteration, since the disregarded parameters would be paid attention to in another iteration. It was also helpful that the evaluation was done continuously with usability studies to ensure the progress of the process.

9.3.3.2 General brainstorming and concept generation

Starting Deliver with a free-thinking ideation was necessary to be able to define what the first prototype should consist of. The method used, braindrawing, turned out to be a good way of creating a creative spiral and a large amount of various ideas were generated. This combined with discussions and individual sketching resulted in a satisfying set of ideas that could be further evolved with the scamper method. The scamper method resulted in well-defined structural concepts and variations of features. It also made it easier to create a first prototype ready for testing. To further increase the creativity of the brainstorming and scampering a workshop could have been held together with some people from the Axis staff to get even more perspectives and concept ideas. This could have resulted in feeding the creativity, but it could also have resulted in influencing the thesis to follow Axis already established way of thinking instead of seeing solutions from a new perspective.

In general, the result of this free creative stage was of benefit to the iterative process since it defined a clear starting point for the first iteration.

9.3.3.3 The first iteration

The outcome of the previous stage made it easy to convert the ideas into a flexible prototype. The structural concepts enabled the flexibility since the variations of the features could be swapped between and during the tests for comparison without affecting the other features or the navigation. This also enabled that there could be different amounts of versions of different features since they could be combined in any way thanks to that they did not affect each other.

The method of lo-fi prototyping in the first iteration made it easy and time efficient to create the first prototype, since it did not need to be perfect in any way and has a large room for development. The prototype could be tested fast and be updated without difficulties since no program or material was needed other than a pen and an eraser. It also encouraged the participants to give feedback. The structure and flexibility of the first prototype made it easy to also design flexible tests with comparisons of variations of features and deeper discussions with the participants. The first prototype was the one of the three prototypes which got the most updates since it was time efficient in being created and updated. The efficiency of the first iteration also increased due to the chosen test methods. The tests were designed to collect qualitative data which made it possible to make updates after each test. Since the result from each test was so elaborated, there was enough support for direct changes.

The focus groups in the first iteration were a good way to collect qualitative data since it generated a large amount of ideas, perspectives and statements from the participants. The single-user tests were also necessary to make sure that statements from participants who were not affected by someone else's opinion or perception of the interaction flow were collected. In the first iteration the cognitive walkthroughs with the personas were useful to broaden the perspectives and emphasize the variation of abilities amongst the real users. Since the participants of the single-user tests and focus groups were a homogeneous group of people, due to constraints in gathering test participants outside of Axis, the cognitive walkthroughs were a way to highlight the abilities and perspectives the prototype were not tested and adapted for. This enabled adapting of the prototype after theoretical assumptions of the struggles some user might experience. This method of testing a design does not give as accurate results as tests with real people, but it gives an idea of how to improve a design in lack of real participants. It is a good way to simulate the experience of the interaction without a lot of effort and enables the design to be better adapted to universal design.

9.3.3.4 The second iteration

In the second iteration it was still too early in the process to create a hi-fi prototype, but the character of the first prototype was too simple for further testing. The second iteration was based on a lo-fi prototype, but a bit more complex than the first one. The structure of the second prototype was the

same as for the first one. The main difference in its structure was that the concepts and variations of the features had been further developed, better integrated and some of them had been discarded. The decision to use the same structure came from the good experiences with it in the first iteration.

Unfortunately, it was not as easy to convert the outcome from the first iteration into a second prototype as it had been to convert the previous outcome into the first prototype. In this stage it became too many new parameters introduced at once. The two biggest differences between the prototypes were the introduction of the button and the application of graphics in the second one. Along with the introduction of the button the design of the structural concepts had to be reconsidered and adapted to either having the button or not. This had such a big effect on the design that it would have been better to update the first prototype with these changes and test its effect on the UX before applying graphics. It was time consuming to create the new concepts with the button and the graphics in mind. It would have gone faster to test and updates with the button using sketches first.

The addition of graphics in the second prototype was the right decision since it has a considerable affect the UX but was done in a time-consuming way with little structure. The graphics were designed one page at a time with the insights from the benchmarking in mind. The evaluation of the graphics was then made at the same time as the evaluation of the UI. This led to that every time the graphics or the UI were changed a big part of the prototype needed to be updated, which was time consuming. It was also difficult to evaluate if the problems in the GUI was because of the graphics or the interaction flow itself. A much better way would have been to first create a set of graphic profiles related to the defined preferences in the benchmarking (in addition to better performed benchmarking on the subject). The graphic profiles could then have been evaluated separately in discussions with a graphic UI/UX designer, a global sales engineer and product specialists at Axis to set an appropriate graphic profile. First after the graphic profile had been set the second prototype should have been created with the integrated graphic profile. This would have made it possible to test the interaction flow in a much more structured way. In total it would probably have taken about the same time to do, but the results would have been more refined.

The methods for the usability studies used in the first iteration, single-user tests and focus groups, worked well in this iteration as well. It was noticed that since the design had already been tested these tests did not need as much discussion as in the first one which was easily adapted to. The cognitive walkthrough on the other hand was not as rewarding as in the first iteration. The insights needed had already been gained and adapted to the UI. This result showed the limitations of a cognitive walkthrough, since it can only help the designer so long. To gain a deeper understanding of the users varying needs, actual test participants with various needs and preferences are needed.

The group of test participants in the second iteration were more varied in both age, occupation, nationality and personal preferences than in the first iteration. Many of the new participants were however working at Lund University, which are highly educated people with some technical interest. This was a result of difficulties in finding a method of gathering varied participants and finding appropriate test environments for a paper prototype.

9.3.3.5 The third iteration

The outcome from the second iteration was clear enough to make a good basis for the construction of the third prototypes. The designs were taken straight from the second iteration therefore the main update was the complexity of the prototype and not the design itself. This was to enable a more realistic test of the features that were difficult to evaluate with a lo-fi prototype and the Wizard of Oz method, such as the search feature. Two separate prototypes were created in the third iteration. The decision to create two separate prototypes was more appropriate in the third iteration since they were created digitally. To have prototypes that worked without being operated by a person enabled fast tests that did not require any preparation to gather quantitative results. The two separate prototypes enabled easy comparisons since they could be mounted next to one another.

The prototypes in the third iteration were created in Adobe XD. This decision was based on the belief that it was the program Axis used for prototypes and that it should facilitate the transition of illustrations made in Adobe Illustrator directly into the program. This turned out to be wrong, since Axis does not actually use Adobe XD. This created struggles since there were no one to ask for help when struggles with the prototyping

occurred. It became both time consuming and frustrating to not get support since some problems were difficult to solve without proper knowledge of the program. Problems with the program concerned adding audio and time-set transitions, which made the final prototypes less smooth. The sizing was also difficult to set to scale 1:1 when the prototype was opened in other units than the computer. This led to that the prototypes had to be redone in a new size since no one knew how to solve the problem. A better way of creating the prototypes would have been to use the program Sketch. Sketch is a similar prototyping program used at Axis. With sketch it would have been possible to get support from an experienced user when struggles occurred.

The tests of the digital prototypes were held in two different ways. In the first test the prototypes were held in the hands of the test leader and in the last test they were mounted on a wall. This turned out to create two totally different perceptions of the product and the context for the participant. This might be due to the fact that most of the participants in the first test were sitting down which did not reflect to how a user would encounter the door station, apart from if being in a wheelchair. That the prototypes were not fixed on an upright wall probably also contributed to the participants perception of the context. They might have perceived the device as something that they could adapt the position of to their preferences or hold in their hand, similar to a tablet or smartphone. When the tests were held with the prototypes mounted on a wall the struggles participants had experienced earlier were no longer noticed. This speaks to the importance of a realistic context and environment for tests to help the participants create a mental model that reflects the reality. The participants in the later tests were also “on the go” when they were asked to participate. That is also more similar to the real situation in which users encounter the door station, than in the focused atmosphere of an office.
The conclusion is that all tests should have been carried out with the prototypes mounted on the portable wall. It would be even better if the wall had been placed outdoors at the entrance of a building. Since the participants of the final tests were Axis employees the results from the tests might be a bit misleading, for the same reasons as the tests in the first iteration. However, it was an easy way to get quantitative results quickly, and a good indicator of the usability of the interaction flows. If there had been more time, additional test had been carried out with the portable wall placed in other environments than at Axis. It would have been an easy and quick way of evaluating the usability with a varied group of test

participants. However, the final tests of the product were carried out with the same method, in the same environment and context and with the same variation of participants as the tests of the current prototype in Discover. This enabled a fair comparison of the test results of the initial UI and the final two designs of the UI. The results showed that the participants had less struggles and were less frustrated in the tests of the final concepts. The comparison of the two tests showed a distinct difference between the usability of the original UI and the ones developed with a human-centered design process. The two final designs turned out to have a higher usability and a better general UX than the original design.

9.3.4 **Deliver**

The deliveries are considered to match the expected outcome for the thesis. The purpose of the thesis is fulfilled even if there is room for further improvement in the created UI. The final usability study proved that the UX is significantly improved by involvement of users throughout the entire development process.

The two final concepts fulfill different needs and are fitting for different use cases. The advantages of *The Display only concept* are that it eliminates the confusion of the external button and that the start page is perceived as more welcoming by the test participants. The participants also claim that the choice between *I am a visitor* and *I am an employee* gives them a confident boost making them feel safe to explore the UI since they know it is all meant for them.

One advantage of *The Button concept* is that the visitors immediately are able to see that they are at the right place since the companies are displayed on the start page. Another advantage is that it separates the interaction flows for the two different types of users, the authorised users and the visitors. Everything on the start page is meant for the visitors. It is also an advantage that wherever the users are in the interaction flow they can always press the external button to reach the keypad. This facilitates the interaction for authorised users if the door station has not had time to reset to the start page after the previous user.

The audio included in the UI is not explored in the thesis, however the parts of the interaction flow that is considered to require audio feedback are marked in the presentation of the interaction flows in Deliver. These

markings are simply a theory of where audio feedback helps the user since the audio feedback was not included in the usability studies. The results of the studies might have differed if audio feedback would have been included. The inclusion of audio feedback in the usability studies would probably have had a positive impact on the result.

The final concepts are designed to achieve forgiveness, one of the characters for universal design. To avoid irreversible error a reversible action in shape of a return option is included in the left corner of every page of the interaction flows. This ensures that the users never get stuck in the UI.

Since the only use case that benefits from *The Button concept* is an unusual use case, it might not be worth the effort of having the external touch button in the hardware design. Since the door station is meant to only have one version of the physical design, the button should be discarded. The other more common use cases would be negatively affected by the presence of the button. The button could in the unusual case, building housing several companies using single identification system with personal digit codes, be replaced by a keypad option in the bottom of the display. It is better to compromise the UX of an unusual use case than several other more common use cases.

10 Conclusion

In this chapter the conclusions for the thesis is presented along with compiled recommendations.

10.1 UX Design and Usability

The earlier in the development process UX design is applied the better will the usability, functionality and UX be. It is essential that the fundamental ergonomics are fulfilled before the hedonomics are applied. It is important to handle a problem at its root and to not just ease its symptoms. The best UX possible will never be achieved if there are problems with the fundamental ergonomics, since they affect the UX way more than the hedonomics. Therefore, usability studies should be applied before major construction and design decisions are made to identify potential issues early on in the process. Lo-fi prototyping and user tests to compare design propositions helps making essential design decisions for an interactive product. Even if a prototype is just made out of paper or cardboard and tape, it enables designers and users to get a grip of the concept. Usability studies should be the foundation of the design decisions throughout the process and not only a way to test the design in the end. In that way it is possible to save time, money and other resources as well as to gain efficiency in the development process and deliver products with a high usability standard.

10.2 A Technology Driven or a Human-Centered Design Process

Applying a human-centered design process in the beginning of the development process of the door station might have affected the choice of hardware and enabled a higher usability. For example, would a bigger touch

display enable a bigger range of desired features. To form a product in a certain size without utilizing the entire surface is inefficient for the user interaction. The choice to separate the external touch button from the rest of the UI also contributes to inefficient confusion, since the decision was not fully supported by usability arguments. The external touch button contradicts the purpose of a digital touch display and inhibits the freedom of having an adjustable UI. The motivation of the existence of the button after the design has been set is an unnecessary step of the process and contradicts the principles of human-centered design. If possible, solutions with and without the button would have been explored and tested in an earlier stage, the decision would have been better supported by usability arguments. Some aspects of the hardware on the other hand could not be adjusted to a human-centered design due to technical requirements. The sensibility of the touch display for example could not be improved due to safety requirements of the products impact resistance. The glass had to have a certain thickness to be able to resist external violence, which affected the sensibility of the touch display.

The conclusion is that a fully human-centered design process is seldom possible in a real technical context. Some parameters are often constrained by the performance of the available technology, which leads to a necessary adaption of the design process to the current circumstances. This does not mean that all technological influences on the design process are justifiable. The technology should be chosen to fulfill the requirements set by usability and UX in the best possible way, instead of the adapting the usability to the the chosen technology. There is a lot to gain by applying human-centered design to the product development process and the involvement of users early in the process has a great impact on the result.

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