Design of a rugged intercom system from an interaction design approach

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Abstract

Within a technology-driven company, product usability and interaction design is usually not the main focus. This thesis applies a Human-Centered design process with the aim of creating a more usable and intuitive product. The project is made in collaboration with Axis Communications who aims to expand its portfolio by transferring two intercoms from its subsidiary 2N Telekomunikace to its own assortment.

This thesis is based on analysing and redesigning these products to follow Axis' design language and quality standards, so they can be added to Axis portfolio of products. To achieve this, an in-depth analysis of their use cases and market potential is made to evaluate which new potential products and concepts can be introduced. Based on these use cases, new concepts are developed, and prototypes are built and tested with users to get relevant feedback. The process is repeated multiple times to iteratively learn from the usability tests and improve the concepts.

The thesis discusses how user involvement affects the results and why interaction design should be considered early on in the development process in order to create a successful product. It also discusses and investigates how a can product communicate with the user and which aspects of a product's design that influences its usability.

The results of this thesis are two different intercom prototypes developed completely based on interaction design and human-centred design. While no direct comparison is made between the usability of these prototypes and similar competitive products, the final usability testing showed that users experienced very few problems in interacting with these prototypes.

Keywords: Axis Communications AB, User Experience (UX), Interaction Design, Human-Centered Design, The Sprint Design, Product development, Prototyping

Sammanfattning

Inom ett teknologi-drivet företag ligger det huvudsakliga fokuset vanligtvis inte på användbarhet och interaktionsdesign. Det här examensarbetet tillämpar en användarcentrerad designprocess i syfte att skapa en mer användbar produkt. Projektet är utfört i samarbete med Axis Communications AB, som i framtiden planerar att utöka sin produktportfölj genom att överföra två porttelefoner från deras dotterbolag 2N Telekomunikace till deras eget sortiment.

I detta arbete så analyseras och omdesignas dessa produkter för att följa Axis designspråk och kvalitetsstandarder, så att de kan läggas till i Axis produktsortiment. För att uppnå detta så utförs analyser av produkternas användingsområden och marknadspotential för att avgöra vilka nya potentiella produkter som kan introduceras. Baserat på dessa användingsområden genereras nya koncept, och prototyper konstrueras och testas med användare för att få relevant feedback. Processen repeteras flera gånger för att iterativt förbättra koncepten.

Arbetet diskuterar hur inkluderandet av användare i utvecklingsprocessen påverkar resultatet, och varför interaktionsdesign borde implementeras tidigt i utvecklingen för att skapa en lyckad produkt. Det diskuterar och undersöker också hur en produkt kan kommunicera med en produkt och vilka aspekter av en produkts egenskaper som påverkar dess användarvänlighet.

Resultaten av det här arbetet är två olika porttelefon-prototyper, utvecklade helt utifrån en interaktionsdesign- och användarcentrerad produktuvecklingsprocess. Även om ingen direkt jämförelse mellan användarbarheten mellan dessa prototyper och liknande produktr så visade de slutliga användartesterna att väldigt få användare upplevde problem när de skulle använda produkterna.

Nyckelord: Axis Communications AB, User Experience (UX), Interaktionsdesign, Human-Centered Design, The Sprint Design, Produktutveckling, Prototyping

Preface/Acknowledgements

This report is the result of a Master Thesis within the program Mechanical Engineering with Industrial Design. This thesis has been conducted at the division of Design Sciences at Lund University, in cooperation with Axis Communications AB.

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Lund, January 2021

Emil Lindgren & Erik Gabrielsson

Contents

List of acronyms and abbreviations

B2B - Business to Business
HCI - Human Computer Interaction
HD - High-Definition
IK - Impact Protection
IP - Ingress Protection
NFC - Near-Field Communication
PMMA - Poly Methyl Methacrylate
SD - Standard-Definition
UI - User Interface
UV - Ultraviolet
UX - User Experience

Chapter 1

Introduction

If you ever pushed a door that was meant to be pulled. Or pulled a door that was supposed to be pushed. You are probably not at fault. Most likely you have been exposed to a bad implementation of interaction design. Something as simple as door-opening-struggles perfectly exemplifies the importance and complexity of designing intuitive and easy-to-use products.

A closed door may have only one possible action (to open it). But how do you know if you are meant to push, pull, or even slide it? Most of the time, these questions do not even come to our minds, because our subconscious answers them for us. But when the design is flawed, even seemingly simple products like doors can be confusing to use. Confusing and unnecessarily complex products tend to leave users feeling irritated and stupid, creating an unwelcoming user experience. This thesis, however, is not about doors, but an extension to doors; intercoms.

The purpose of this thesis is to develop two rugged[1] intercom systems with an interaction design approach for Axis Communications AB. The aim is to evaluate and analyse two existing intercoms' designs, use cases and market potential and redesign them to fit Axis portfolio.

[1] Robust and capable of withstanding rough handling.

During this project, the following questions will be examined:

- What makes an intercom intuitive and easy to use?
- How can we design an easy-to-use intercom?
- How can companies benefit from an interaction design focused product development process?

A Human-Centred Design(see Section 4.1) process is used to develop a solution that improves efficiency, human well-being, accessibility and user satisfaction (ISO 9241-210, 2010, p. 1). This is combined with the Design Sprint methodology(see Section 4.2) to iteratively test out concepts and ideas rapidly. The Design Sprint enables a fast-tracked product development to produce realistic prototypes and receive customer reactions early on, before making any expensive commitments (Knapp et al., 2016, p. 3).

Some delimitations were established to narrow down the project's scope to a realistic and reasonable workload. While a part of this project revolves around producing rugged products, this thesis will not delve into the specifics of developing something rugged. But rather on concepts that provide a foundation for Axis to stand on while continuing to work on this project.

Chapter 2

Background

2.1 Axis Communications AB

Axis Communications AB is a Swedish manufacturer and developer working with network video, audio and access control solutions (Axis Communications AB, 2020). Axis was founded in Lund in 1984 and focused during its early years on producing and selling print servers. Since 1996 however, it started selling network-based security cameras which have now become the cornerstone of its business. While Axis has been a part of The Canon Group since 2015, it is still an independently run company (GIT-Security, 2011).

2.2 Door Stations and Intercoms

In addition to Axis' main products, security cameras, it has in recent years also started developing intercoms, which may also be referred to as door stations. Intercoms are, according to Axis (Axis Communications AB, 2020);

Axis Network Intercoms combine video surveillance, two-way communication and remote entry control in a single device.

In more simple terms, an intercom is a device that controls who is able to enter a building or property. This is usually done by either an access card, security code, or calling someone who remotely unlocks the door. Modern intercoms often include security cameras to be able to identify visitors without letting them enter.

The Axis Intercom exists in several different configurations depending on the relevant use cases of the customer. For instance, intercoms with, or without card readers exist to reach customers without the need for access card functionality. An example of an Axis Intercom can be seen in Figure 2.1 below.

Figure 2.1: Network Door Station A8207, This intercom contains a camera, card reader, speaker, microphones and a numpad used for security codes and call functionality (Axis Communications AB, 2020).

2.3 Axis' Customers

Axis is a Business to Business (B2B) based company where the end customers are owners of commercial real estate or institutional and educational properties. Axis does not sell directly to these entities but uses distributors and resellers to reach the end customer. An illustration of Axis supply chain is shown in Figure 2.2 below. While Axis is a global company, a majority of its sales are made in the US.

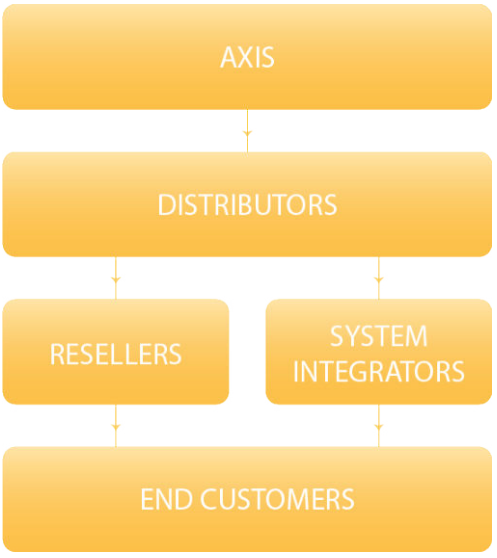


Figure 2.2: The supply chain of Axis.

2.4 2N Telekomunikace

2N Telekomunikace is a Czech telecommunications company acquired by Axis in 2016. In recent years, Axis has gone beyond its core business of cameras, and expanded into speakers and intercoms, an area where 2N have a lot of experience. 2N's portfolio differs from Axis in that their target customers are in the residential market, where as Axis target customers are in the enterprise market. 2N's current portfolio contains the two intercoms IP Force and IP Safety which can be seen in Figure 2.3 below.

(a) IP Force (2N, 2020) **(b)** IP Safety (2N, 2020)

Figure 2.3: IP Force and IP Safety.

With their robust aluminium frames, the main selling point of these products over their competitors is that they are engineered to withstand harsh conditions. Within the technology industry, ruggedness of electronic devices is usually measured with the Ingress Protection (IP) and Impact Protection (IK) standards. The Ingress Protection rating describes a products resistance to dust, accidental contact, and water (Svenska Institutet för Standarder, 1992) and the Impact Protection rating is a numeric classification of a devices protection against mechanical impacts (Svenska Institutet för Standarder, 2008). IP Force and IP Safety fulfils the criteria to achieve the highest ratings of both these standards, which gives them an IP69 and IK10 rating. From this point onward, a rugged product in this thesis refers to something that satisfies these criteria.

While both IP Force and IP Safety are intercoms, their intended use cases are completely different. IP Force is used for access control for buildings and properties while IP Safety is used to connect people in need with emergency services. Both products are also designed with different modules so they can be customised depending on the situation. In addition to the previously shown products(see Figure 2.3), the other models currently available are displayed in Figure 2.4 below.

(a) One button.

(b) Four buttons.

(c) Two buttons, card reader

(d) One button, card reader.

(e) One button.

(f) Mushroom button.

Figure 2.4: The different configurations of IP Force and IP Safety

Besides these options, customers can also decide whether they want an High-Definition(HD) camera, Standard-Definition(SD) camera or no camera at all. These different alternatives amount to a total of 18 different configurations.

2.5 Conditions for the thesis

Because these intercoms are meant for the enterprise market, and 2N focuses more on the residential market. Axis aims to transfer its use cases to their portfolio. To fit into Axis' assortment of products, they have to be redesigned to follow Axis' design language and quality standards. This thesis is based on this task. To achieve this, an in-depth analysis of their use cases and market potential is made to evaluate which new potential products can be added to Axis' assortment.

A total of 18 configurations of IP Force and IP Safety currently exists in 2N's portfolio. With configurability comes a more expensive product cycle, with greater manufacturing and warehousing costs. All different use cases of these configurations are investigated to evaluate the possibilities of reducing the number of configurations to one, or a couple of products. To develop these products, an Interaction Design and Human-Centered approach is used (see section 3.1 and 4.1).

2.6 Understanding Axis' Design language

The aesthetic aspect of product design is difficult since a products aesthetic appeal is completely subjective, and designing beautiful products is not necessarily correlated to designing good products. There are, however, factors such as market trends, brand identity and customer preferences that industrial designers consider to create successful products (Larsson, 2014). To Axis, a uniform and company-wide design language is important. Axis' products have a well-engineered, and high quality feel to them, and they intend to create products that express, in their words, sophisticated robustness.

Chapter 3

Theory

The subject of designing intuitive systems and products is not an absolute science, and several different models have been developed to explain how a successful product is created. Many of these interlace, and blend as they describe very similar concepts. The theory that this thesis is based on is presented in this chapter.

3.1 Interaction Design

Interaction Design is the design of the interaction between users, and systems or products. Similar terms like interface design, software design, experience design and user-centered design are all included within the field of Interaction Design (Rogers et al., 2011, p. 9). Today, Interaction Design is usually associated with digital and software products. However, it also includes the interaction with physical products. The goal of Interaction Design is to develop products that achieve the expected outcome as intuitively and simple as possible (Siang, 2020).

The Interaction Design methodology is not fixed to a particular set of methods, but is more eclectic and includes a wide range of techniques and frameworks. These different methods, however, all follow the same basic principles (Rogers et al., 2011, p. 15);

- **Establishing requirements:**

  Whether the problem at hand is to develop a completely new product, or update an already established system, the users' needs and requirements have to be discussed, analysed and structured in order to understand how to design a solution that fits the user (Rogers et al., 2011, p. 352).

- **Designing alternatives:**

  Based on the established user requirements, alternative solutions and ideas are created. These are discussed and evaluated to determine which alternatives are most likely to satisfy the user requirements (Rogers et al., 2011, p. 389).

- **Prototyping:**

  The chosen alternatives are made into one, or a couple of prototypes. Early on in the process, these prototypes may be made of paper or cardboard, these are called Low-Fidelity(Lo-Fi) Prototypes. Later stages in development usually include more advanced prototypes, that looks and functions as finished products. These types of prototypes are called High-Fidelity(Hi-Fi) Prototypes (Rogers et al., 2011, p. 409).

- **Evaluating:**

  Evaluation is integral for a well executed design process. Without evaluation, the product is only a result of predetermined facts and the designer's opinions. While this may work, designers' prejudice of how a user might act is usually not correct. Consequently, prototypes have to be made, and get tested by relevant users in order to discover problems before the finished product is completed (Rogers et al., 2011, p. 435).

3.2 The Seven Stages of Action

The Seven Stages of Action is a model consisting of seven questions that a user should be able to answer when using a product. This is a useful tool to determine in which part of the interaction process a product may be lacking (Norman, 2013, p. 71). It consists of the following questions:

1. What do I want to accomplish?
2. What are the alternative action sequences?
3. What action can I do now?
4. How do I do it?
5. What happened?
6. What does it mean?
7. Is this okay? Have I accomplished my goal?

3.3 The Seven Fundamental Design Principles

The seven fundamental design principles is a model consisting of seven attributes that define a product's usability. Every attribute has to be carefully considered to ensure an enjoyable user experience (Norman, 2013, p. 71). The seven fundamental design principles are described below.

Discoverability

Whenever a user engages with a product, they have to figure out where, and how, to perform its various functions. An object's discoverability describes its ability to communicate to the user how it is meant to be used. A common mistake is to design a product with too many buttons and functions, leading to a cluttered and confusing interface, with poor discoverability (Norman, 2013, p. 31). This can often be seen in remote control devices, an example of this can be seen in Figure 3.1a below.

(a) **(b)**

Figure 3.1: Remote controls are often designed to include as many functions as possible. Consequently, the limited space creates a cluster of arbitrarily placed small buttons(Figure 3.1a). The TiVo remote(Figure 3.1b) was designed with a user-centred design process and is praised, and often referenced as a well designed product in interaction design literature. With different sized buttons it creates a clear visual hierarchy. Commonly used buttons are made bigger, and different colours are used to differentiate functions and increase low-light visibility, this creates good discoverability (Rogers et al., 2011, p. 5).

Feedback

When a product is used, the way in which it communicates the result of an action is called feedback. Important information should be immediate and communicated clearly. Without immediate feedback, users are left wondering if their action actually succeeded. Lacking, or slow feedback is often a cause of irritation and can affect the user experience negatively (Norman, 2013, p. 23).

Feedback can be communicated with either aural[1], visual or tactile feedback. Studies have shown that using multisensorial feedback, produce higher accuracy and fewer errors than using just one type of feedback (Lee & Zhai, 2009). For instance, a smartphone can use a combination of all three types when a button is pressed by; changing the look of the button (visual),

[1]Relating to the ear or the sense of hearing.

producing a clicking sound (aural) and using the haptic motor to create a slight vibration (tactile).

Conceptual Model

A conceptual model explains, often with simplified visualisations, how a function or action works. For example, a trashcan icon on a computer's desktop creates a conceptual model of a location to put unwanted files in. There is no physical trashcan within the computer, but the resemblance of a physical object with the same function lets the user know how it works (Norman, 2013, p. 25).

Conceptual models can differ depending on the user, as they derive from the user's previous experiences. Different cultures can have contrasting conceptual models. For instance, the thumbs-up gesture is a sign of approval in most countries. However, in some countries in West Africa and the Middle East, it is used in the same way that the middle finger is used in the US. It is essential to ensure that the conceptual models used are relevant for the target users (Norman, 2013, p. 27).

Affordances

Affordances describe the varying ways in which a product can be used. They refer to the possible interactions between an object and its user. For example, a coffee cup affords to be picked up with one hand, it also affords to be filled, and emptied. Anti-affordances refer to the opposite phenomenon, floor-to-ceiling windows affords transparancy, but not passage. It is important to communicate both affordances and anti-affordances clearly. Every year, numerous people walk straight in to closed glass doors and windows because of poorly communicated affordances (Norman, 2013, p. 11).

Signifiers

Signifiers are the tools used to communicate a product's affordances. In practice, designers use signifiers to guide the user through the interaction process. The handle of a coffee cup signifies where to pick up the cup, and a sign with the word push or pull can signify how to operate a door. Touch screen buttons often use fake shadows to replicate the look of physical buttons in order to signify that they are clickable (Norman, 2013, p. 14).

Mapping Mapping is a term describing the placements of a product's controls, and is vital in the design and layout of displays and controls. What users consider intuitive mapping is usually correlated with their conceptual model of the product. The easiest way to ensure intuitive mapping is to use spatial correspondence. If two light switches controlling two different lights are adjacently placed, spatial correspondence implies that the switch closest to a light, controls that light. It also implies that a control that moves an object upwards, should have a control moving the same direction.

Another important mapping aspect is the distance, and contextual placement of controls. A control should be placed close to the object being controlled, and similar controls are often grouped together to create an intuitive mapping. For instance, the menus of phones and computers are usually categorised, in order to make it easier for users to find what they are looking for (Norman, 2013, p. 22).

Constraints

Constraints are used in interaction design to restrict the possible uses of a product, to guide the user's actions and simplify interpretation. This is done to reduce the risk of errors and make the interaction process less complex. In a graphical interface, irrelevant buttons and functions can be greyed out to signify that they are not usable at that moment (Rogers et al., 2011, p. 27).

Physical, cultural and semantic constraints also exist. Some circular saws require the plastic cover to be placed over the blade in order to start the saw, this physically constrains the user to use the saw correctly, and minimises the risk of injury. Cultural constraints are controlled by environmental human behaviour, and in riding an elevator with strangers, a cultural constrain usually makes all passengers face the same direction. This happens because humans tend to match their behaviour to the environment. Semantic constraints depend on the environment and situation in which the product is placed. A steering wheel air-bag is semantically constrained because the placement is chosen because of where the driver's head would impact in a frontal collision (Norman, 2013, p. 129).

Chapter 4

Methodology

4.1 Human-Centered Design

Human-Centered Design is an approach to interactive product development that focuses on the users and their needs. By applying knowledge about ergonomics, usability and interaction design, this approach improves efficiency, human well-being, accessibility and user satisfaction. Furthermore, it prevents dangerous misuse of the products, protecting the user from potential harm (ISO 9241-210, 2010).

4.1.1 Reasons for adapting Human-Centered Design

A Human-Centered Design approach during product development has significant social and economic benefits for users, employers and suppliers (ISO 9241-210, 2010). Designing systems and products with a Human-Centered Design methodology can lead to:

- Increase in productivity of users and efficiency of organisations.
- Simpler products that are easier to understand, leading to reduced costs in training and support.
- Products suitable for people with ranging abilities and disabilites. Thus increasing accessibility.
- Improved user experience.
- Preventing misuse and errors, leading to reduced discomfort and stress.

4.2 The Design Sprint

The Design Sprint is a methodology developed at Google Ventures to quickly validate ideas, solve problems and answer critical questions early on in the product development process. It is an iterative method where the process can be repeated to improve the product or concept with each iteration. The basic idea is simple, take the most important parts of a design process and confine it into five days (Knapp et al., 2016, p. 9).

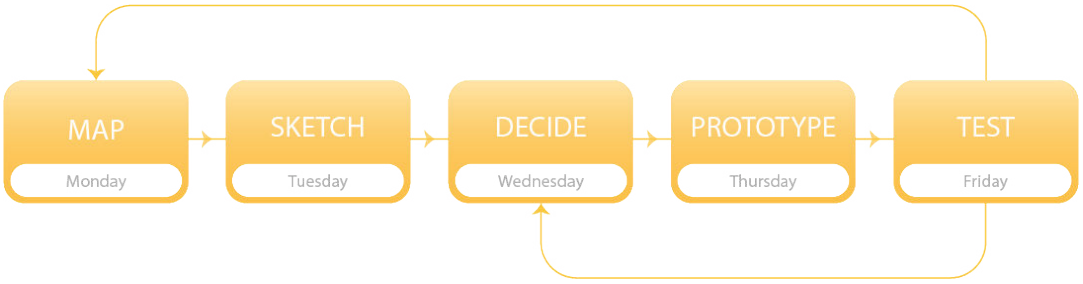


Figure 4.1: The Sprint Design works as a shortcut for teams to learn from their mistakes and successes early on.

The Design Sprint was created within Google LLC to be able to test out ideas, without creating big projects and spending large amounts of time and money. This enabled a more liberal approach to new ideas, as fewer resources were required. It begins with a formulated problem or an idea. A team, including experts within the project's affected fields, is involved to get relevant feedback during each step. These teams usually consist of between five and ten people involved (Knapp et al., 2016, p. 29). This process, however, was revised to fit the scope of this project. A majority of the steps in this process are performed by the two authors of this thesis, with experts from Axis used for consultation when needed.

The Design Sprint is split up into five days, each day with a different theme and goal. The steps of the Design Sprint are explained below.

- **Monday: Map**

  The Design Sprint begins with a mutually decided long-term goal. A conversation within the team is held to discuss how the sprint could benefit the company in the long run, and what the ideal outcome would be. Then, a couple of Sprint Questions are created. These questions are based on what problems might be encountered during the sprint, what questions need answering, and what has to be true to succeed with the long-term goal.

  With a long-term goal and Sprint Questions created, the foundation of the sprint is completed. The next step is to produce a map. The map starts with listing the stakeholders, and ends with a goal of the sprint. The space in between is filled with the actions every stakeholder performs when they interact with the product.

  Based on the map, an exercise called How Might We-notes HMW is performed, this is further explained in section 5.6.1. The final step of the mapping process is to decide on a target, the most important customer and the most critical moment of the customer's experience is mapped out as a focal point for the future of the sprint (Knapp et al., 2016, p. 59).

- **Tuesday: Sketch**

  The second day is focused on sketching ideas and coming up with solutions. The previously created map is used as a reference, and techniques such as Lightning Demos and The Four Step Sketch are used to assist this process. These are further explained in Section 5.6.1. The sketching process may be the most important step of the Design Sprint, as it lays the foundation for the prototyping and testing phases coming up later (Knapp et al., 2016, p. 94).

- **Wednesday: Decide**

  By Wednesday, several ideas and sketches have been produced. The next step focuses on discussing and evaluating the ideas, and deciding which ideas to implement in the prototype. When the most promising ideas have been decided, the prototyping phase is planned out and a storyboard is created. A storyboard illustrates the steps the user might take when they interact with the product. The storyboard is later used as a reference for the prototyping and testing processes (Knapp et al., 2016, p. 126).

- **Thursday: Prototype**

  Thursday is all focused on creating the prototype. Depending on the use case, either a Lo-Fi or a Hi-Fi prototype can be produced. The important factor is to ensure that the prototype allows a realistic testing scenario. Based on the complexity of the prototype, this process can take more or less time. Modern prototyping tools such as 3d-printing and laser cutting, combined with software like Adobe XD or Figma can be used to quickly create realistic looking prototypes. When the prototype is finished, the testing process is prepared and planned out (Knapp et al., 2016, p. 164).

- **Friday: Test**

  On Friday, all ideas implemented in the prototype are evaluated in the testing process. Relevant users are tested and interviewed to learn what ideas works, and what needs to be reevaluated. It is important to keep the testing process unbiased to predetermined opinions by making sure not to nudge the users in the right direction or asking leading questions during the interviews (Knapp et al., 2016, p. 212).

Chapter 5

Process

Since this thesis aims to develop something new, without a definitive end product, the Design Sprint methodology was deemed suiting. Together with Human-Centred Design, and a focus on the Interaction Design aspect of product development, a blend of these methods is used to approach this project. Since the field of Interaction Design is eclectic, these methods are not followed in a rigorous fashion, but mixed together and used as a guide throughout the process. Nor is the time schedule of performing a Design Sprint in the span of a week strictly followed, as some parts of the process are allowed to take more time.

5.1 Development process

To start the development process, all possible use cases for the 18 different configurations of IP Force and IP Safety are listed (see appendix A) and discussed with the product owner at Axis, to shape a clearer image of where these products are actually used. Based on internal data from 2N, the following products are chosen as the most important products to focus on.

Figure 5.1: IP Force with One button, HD camera (2N, 2020)

Figure 5.2: IP Force with Card reader, HD camera (2N, 2020)

Figure 5.3: IP Force with Keypad, Button, HD camera (2N, 2020)

Axis has already developed an intercom covering the same basic functions of 2N's intercom with one button and an HD camera. Because this product also achieves an IP69 and IK10 rating, its use cases are considered to already be covered by Axis portfolio, and are not focused on in this project. The code name of this product is called Jake and can be seen in Figure 5.4 below.

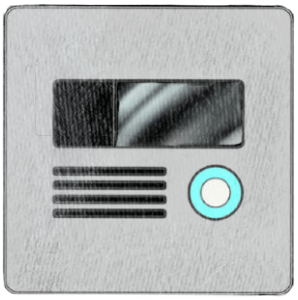


Figure 5.4: Axis intercom Jake with one button, and an HD camera.

5.2 Identifying Stakeholders

Stakeholders are people, companies or organisations who either affect, or are affected by a product and its outcome. They include everyone, from the manufacturer and sales personnel, to installers and the primary users of the product (Rogers et al., 2011, p. 333). This thesis focuses mainly on the primary users of the product. Consequently, other stakeholders affected by this project will not be thoroughly investigated. Nevertheless, using a Human-Centred Design process usually leads to more intuitive products, benefitting every stakeholder in the process (ISO 9241-210, 2010, p. 4).

5.2.1 Primary users

Users of intercoms, and emergency phones especially, should be able to be used by anyone, regardless of their age and physical abilities. Since Axis is a global company with sales all over the world, this also means that cultural and linguistic background have to be accounted for. Special considerations have to be made in the design process, in order to create a product that is accessible and usable by everyone. These considerations include visual and aural degradation for elderly, wheel chair accessibility and language, to name a few (Centre for Excellence in Universal Design, 2013).

5.3 Benchmark

To investigate the current market's state on intercoms, a brief benchmarking process is performed. The goal of this benchmark is to study customers' expectations of an intercom, and find out the different functions available on existing intercoms today. A majority of the evaluated products use physical keypads and buttons and does not show any distinguishable features. Some, however, also offer two-way video communication, so the user can see the person they are talking to. The complete benchmark can be seen in Appendix F.

5.4 Functional analysis

A functional analysis can be incorporated into the requirements analysis of a design process, and is used to paint a clearer picture of which functions the product should include. The intended target users and use cases are discussed, and a list of functions is compiled and classified (Magnusson et al., 2009). To produce the functional analysis for this project, the different use cases of IP Force and IP Safety (see appendix A) were discussed with relevant stakeholders within Axis. The most important functions were then compiled and classified according to each function's importance. The functional analysis produced in this thesis can be seen in Table 5.1 below.

Functional Analysis for this thesis. **MF**=Main Function, **N**=Necessary Function, **D**=Desired Function	
Rating	**Function**
MF	Use access card
MF	Call for emergency help
MF	Call receptionist or other relevant person
N	Camera used for authentication
N	Input PIN-code
N	Gives clear feedback
N	Rugged Design
D	Alternatives for calling different people
D	Be perceived as modern
D	Follow Axis design language
D	Camera used as surveillance
D	Visible in direct sunlight
D	Usable by elderly
D	Compliant with regulations in specific countries

Table 5.1: Function analysis.

5.5 Establishing System Requirements

Establishing system requirements is a method used to convert the user needs into more absolute terms (Rogers et al., 2011, p. 355). Based on the ruggedness of IP Force and IP Safety, the technical specifications of similar Axis products, the benchmarking process, and the functional analysis, a list of ideal system requirements is created to cover all of the use cases. These are hardware requirements that give a better understanding of what a rugged intercom needs to be able to withstand the harsh environments in which it can be placed. It also translates the functional analysis into more physical properties.

Since these system requirements are based on the specifications on already existing products and the authors' opinions, and does not include actual users, these requirements are updated throughout the process as user feedback is received and analysed. The system requirements are divided into Critical and Normal requirements and can be seen in Table 5.2 below.

System Requirements		
Requirements	**Value**	**Importance**
Temperature	-40 °C to 60 °C	Critical
Size	Not yet decided	Normal
Fire Safety	Not yet decided	Normal
Environment	Withstand wind, rain and snow	Critical
Ingress Protection	IP69	Critical
Impact Resistance	IK10	Critical
UV	UV-resistant	Critical
Pictogram	Not yet decided	Normal
Card Reader	YES	Critical
Camera	YES (HD, wide angle)	Critical
Speaker	Clear in loud enviroments	Critical
Microphone	YES	Critical
Visibility in	Direct sunlight & at night	Critical
Keypad	YES	Normal
Emergency Button	YES	Critical
Humidity	Usable when wet	Critical

Table 5.2: System Requirements.

5.6 Sprint 1

To create a product fulfilling the system requirements, a Design Sprint is initiated. To start off the first sprint, a long term goal is decided to: **Increase intercoms' usability.** This goal is broad, but is deemed suitable for the beginning of the project. A sub-goal of this sprint is to achieve a better understanding of the different aspects of an intercom's usability. Since the use cases of IP Force and IP Safety are quite different, this sprint focuses on the use cases of IP Force (see appendix A).

A couple of sprint questions are asked to better conceptualise and understand the aspects that make up an intuitive and rugged intercom. The following sprint questions are asked:

- Whats makes the user experience positive/negative?
- How will the user understand how to use the product?
- How should the product communicate with the user?
- How do we make sure the product endures the environment in which it is placed?

5.6.1 Map

A map is created to get an overview of where each action is happening in the interaction process, and which stakeholders are involved. The map begins with the affected stakeholders, or actors, and ends with an end goal that specifies the intended outcome. It describes the different functions and actions that the actors use, and is divided into three steps; discover, learn, and use. The map aids the design process in creating a better understanding of how the different aspects of a product's interaction process affects each other and the stakeholders (Knapp et al., 2016, p. 59). This is useful in the future of the sprint to evaluate what to develop and focus on. The map created for the first design sprint can be seen in Figure 5.5 below.

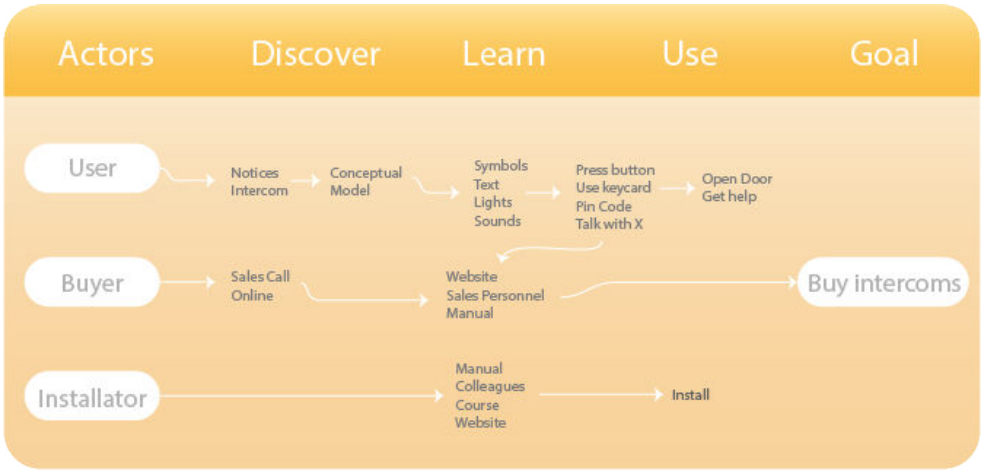


Figure 5.5: The Sprint 1 map.

The next step is How Might We-notes (HMW). It is a note-taking technique where notes are taken in the form of a question. These questions all begin with the phrase "How might we...?" and should be relevant to the different aspects of the product. This type of phrasing is used to focus on solutions, rather than the problem itself (Knapp et al., 2016, p. 75).

The questions are individually written down on post-it notes by each member of the team. The notes are then organised into categories and put up on a wall or whiteboard. Each member of the team goes through all of the notes and votes, with the use of coloured stickers, on the most interesting ones. The How Might We-notes used in this sprint can be seen in Figure 5.6 below.

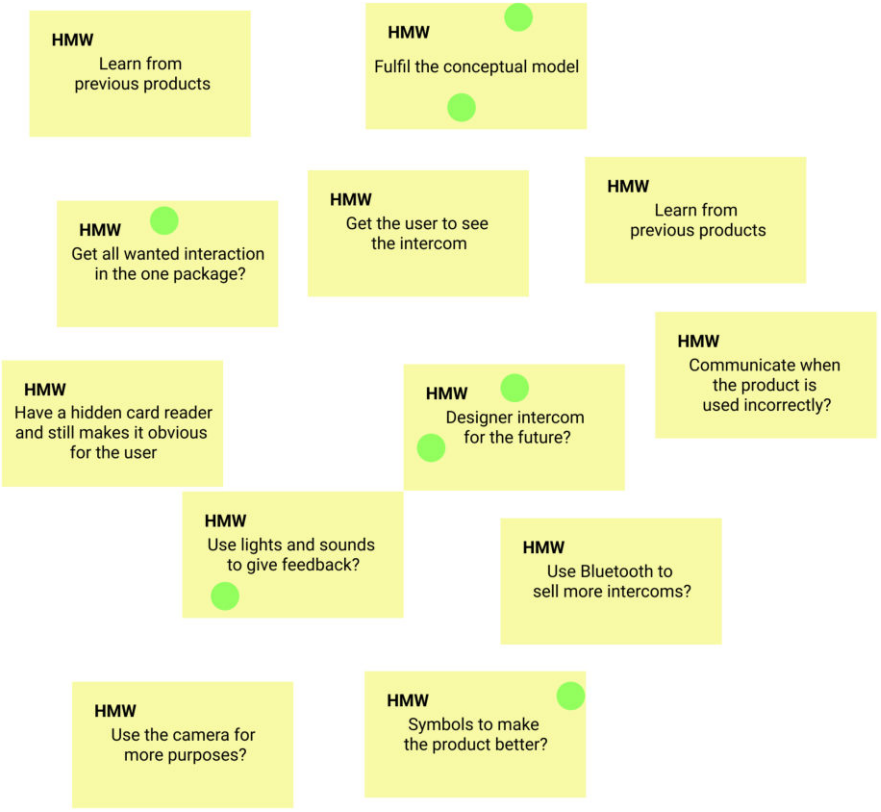


Figure 5.6: HMW Notes in Sprint 1.

Once the How Might We-process is completed, the most interesting notes are placed on the map, next to relevant stakeholders and actions. This creates a clearer image of where the most critical parts of the map might be. A stakeholder and section of the map is decided as the main focus for the rest of the sprint. In this sprint, the learn, and use steps of a user's interaction process were chosen.

5.6.2 Sketch & Decide

The sketching process in a design sprint is initiated by performing an exercise called Lightning Demos. This exercise is used to generate new ideas and solutions, by looking at inspiring products and solutions in other fields (Knapp et al., 2016, p. 96). These solutions or products are then discussed to determine why they worked, and if they can be applicable to this project. A couple of the Lightning Demos from this sprint are:

- **Chrome Autofill:**

  Remembers your information to quickly fill out forms and payment options. This is a function that aids the user, as less information have to be remembered, and time is saved. This can be applicable for intercom purposes because a PIN-code in many cases has to be remembered. Some discussed solutions to this problem included use of biometric authorisation and facial recognition as a second authorisation method.

- **Popup Camera in phones:**

  Keeps the camera hidden when not in use, ensures the user when the camera is active. This is relevant to this project because the product developed also includes a camera, and similar functions are considered to be included in the future.

The Lightning Demos are used as inspiration for the next step of the sketching process (Knapp et al., 2016, p. 109), the Four Step Sketch. Every step is performed individually by every member of the team. The steps included in the Four Step Sketch is described below.

- **Notes**

  The Four Step Sketch begins by looking through the map, HMW-notes, Sprint Questions, and Lightning Demos and writing down the most important ideas, problems, and concepts (Knapp et al., 2016, p. 110).

- **Ideas**

  After notes are written down, a 20-minute brainstorm is performed. Here, ideas are roughly sketched and written down. No specific method have to be used, as long as everyone is thinking and getting their ideas on paper (Knapp et al., 2016, p. 111).

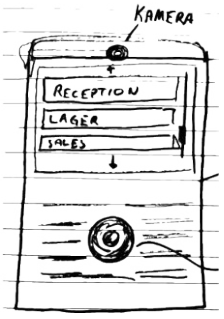
- **Crazy 8s**

  Crazy 8s is a fast-paced exercise where every person sketches down their best idea in eight different variations, using one minute for each one (Knapp et al., 2016, p. 112).

- **Solution Sketch**

  The four step sketch ends with a more thorough solution sketch, where each team member's best idea is sketched and explained in detail (Knapp et al., 2016, p. 114).

The sketching process resulted in two potential concepts; The Joystick, and The Click Screen.



(a) The Joystick

(b) The Click Screen

Figure 5.7: The two potential concepts.

The Joystick

Joysticks are usually utilised in gaming devices to intuitively move around in games and menus. The idea behind The Joystick is to investigate how a joystick would perform when used in an intercom.

The Joystick is an intercom with a non-touch display, where all interaction with the device goes through the joystick, which also functions as a button. After some discussion, a decision is made to put this idea on hold for the time being, and continue working on the other main concept.

The Click Screen

The Click Screen is based around the idea of having a screen that also works as a physical button. As it works now, there are two devices that control the unlocking, and opening of a door. An intercom is used to unlock the door, and a separate button opens it. Here, the idea is to have the screen of the intercom working as an opening button for the door.

This idea is chosen for further development. Some other sketching process ideas are also incorporated into the design, and the first concept is created. The main features to evaluate in this concept are:

- A back-lit capacitive touch numpad (instead of physical buttons), with painted buttons, used as the interactive medium.
- A card sized frame to indicate where to put the access card in order to unlock the door.
- Try out a calling functionality and how it works.
- The screen-button functionality.

In further evaluating the initial sketch, and planning the prototyping process, some design changes are made due to limitations in building the actual prototype. In the original drawing, the capacative touch numpad is protruding, in the exact size of an access card. The prototype, however, uses a smartphone to create the numpad. Since the smartphone is bigger than an access card, a light border surrounding the keypad is instead used as a signifier to indicate where to put an access card. The screen button functionality is also revised as it is difficult to incorporate into the prototype. This functionality is also questioned, as buttons are placed on top of another button, which may cause unintentional button presses.

A storyboard is created to illustrate the steps that a user might take (See Figure 5.8). It is also later used as a reference for the testing process. The storyboard includes the fictive user Jim and his interaction process.

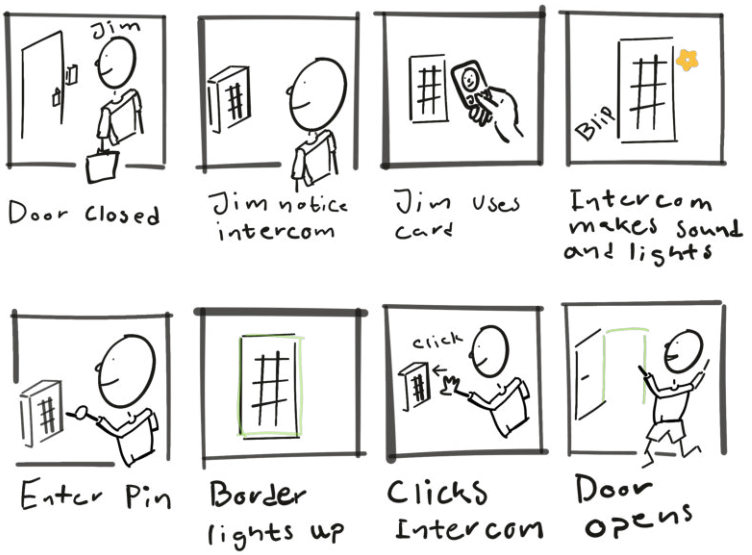
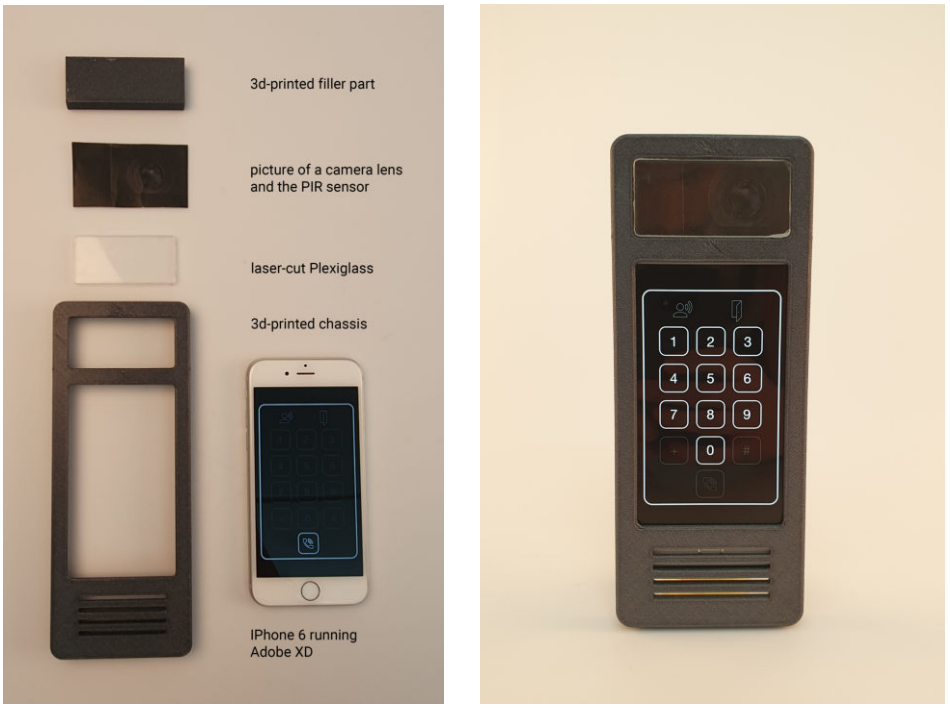


Figure 5.8: The Storyboard 1 with Jim.

5.6.3 Prototype

The prototype is based on a smartphone running Adobe XD used as the interactive medium. A 3d-printed chassis is designed and printed as the frame for the prototype. To add a convincing look and realism, a picture with a camera lens and is printed and placed behind a piece of laser-cut acrylic glass (PMMA) on top of the prototype.

The prototype is designed for two different scenarios. The first use case is calling a number to reach a person within the building, for instance a reception, who remotely unlocks the door. The other use case is to use an access card and PIN-code to unlock the door. The finished prototype is named Barbro and can be seen in Figure 5.9 below.



(a) The prototype Barbro before assembly **(b)** The prototype Barbro after assembly

Figure 5.9: The finished prototype.

5.6.4 The User Interface

The user interface (UI) of Barbro is designed with The Seven Design Principles in mind. In the default screen (see Figure 5.10), only the light border and phone button are illuminated to constrain the user to two possible actions. Either by placing an access card in front of the device, or by pressing the phone button to start the call functionality. A conceptual model is used for the call button in the form of a telephone icon. This is done to increase the product's discoverability by letting the user know which two actions are possible.

Once the first action is performed, the light border flashes and a beeping sound is heard to give the user feedback that their action worked. Then the numpad lights up to indicate to the user that a PIN-code or phone number should be entered.

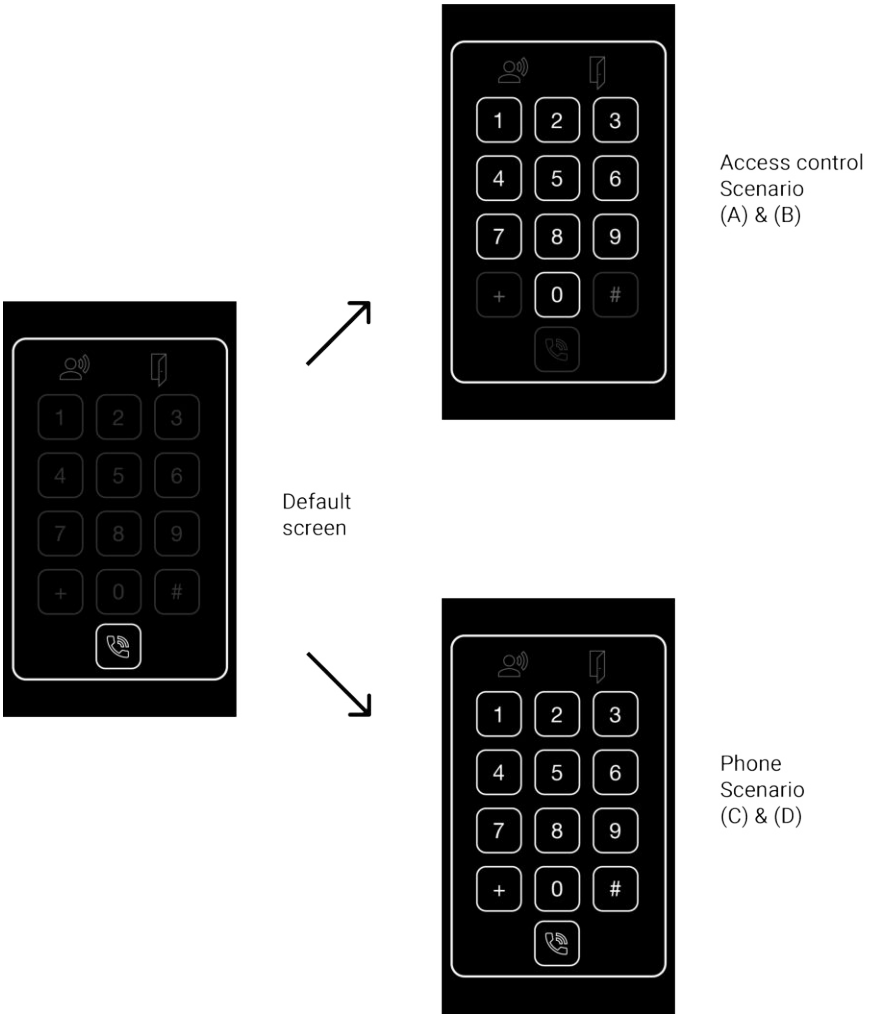


Figure 5.10: The initial interaction process steps.

In the second step of the action sequence, the user then has to input either a PIN-code or phone number. Every button press provides the user feedback with an illuminated button and beeping sound. The border also flashes in green when the door is opened, and red if the wrong PIN-code is inputted. Two pictograms are placed above the keypad to show the user when a call is accepted, and if the door is open. An illustration of the complete action sequence can be seen in Figure 5.11 below.

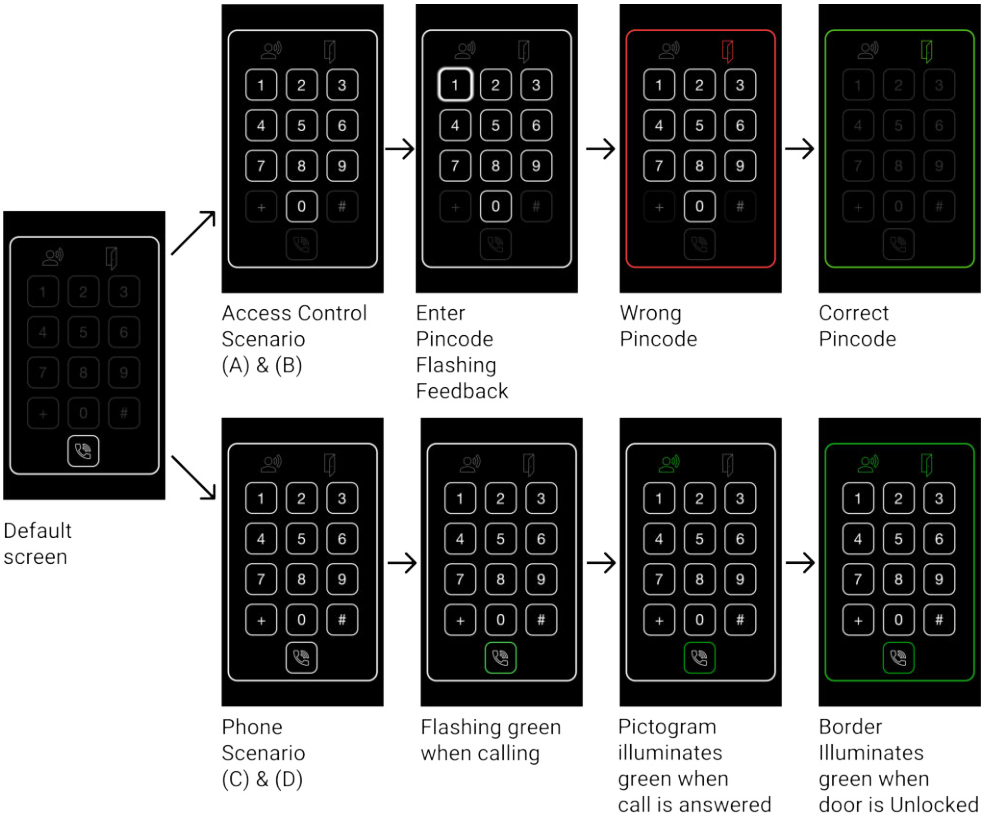


Figure 5.11: The user interface of Barbro.

5.6.5 Test

The testing process begins with a couple of questions, intended to conceptualise the aim of the test:

- Does the card-sized rectangle clearly indicate where to blip the card?
- Does the user have problems figuring out how to use the product in the intended way? If so, what is the problem?
- Is the touch pad a good/sufficient solution compared to physical buttons?

Usability studies are performed to test if the product is usable by the intended user population. Collecting data about the users' performance during the tests is essential. This data can be collected with various different methods (Rogers et al., 2011, p. 477). For this project, the users' actions and problems are monitored by a moderator writing notes. After each test, a short interview is conducted with each user to assess their satisfaction of, and collect additional information about, the user experience.

An important factor to consider is the number of users involved in the testing process, five to twelve participants is considered an acceptable number (Rogers et al., 2011, p. 477).

Four different testing scenarios are created, with the intention on testing two scenarios on each participant. Each user tests a scenario for both the access control and call functionality of the intercom. The order in which the scenarios are performed is altering for different participants to eliminate the risk that the user might get more familiar with the device, thus affecting the results. The different scenarios are described below.

(A) The user gets an access card to the intercom and should enter a door where the intercom is installed. Here the user's code is 6809. The user gets a note with the code which can be interpreted as both 6809 and 6089 depending on which way the user sees it. This code is chosen to test how the user experiences the intercom when an incorrect code is used.

(B) Similar to scenario A but with the code 2255, to evaluate how the user performs on repeating numbers.

(C) The user has a scheduled meeting at a company where they have not been before and approaches the entrance door where the intercom is located. A sign with numbers for calling the reception and warehouse is placed next to the intercom. The user is instructed to find a way to enter the building via the intercom. Preferably by calling the reception.

(D) The user is a delivery person and needs to access the company warehouse, the user therefore, should use the intercom to contact the warehouse.

It is useful to perform pilot studies of the test before the actual testing process begins. This is done to discover potential shortcomings in the planned test (Rogers et al., 2011, p. 460). Two pilot studies were performed before the start of this testing process. A problem discovered was that the initial height of the intercom was put too low. By researching the subject, a normal placement was found to be 1-1,6 meters above the floor (Axis, 2020). A height of 1,3 meters above the floor was decided to be used for these tests . Another change, was that users were not told that their access card is supposed to be placed in front of the device.

The Testing Process

Eight users participated in the testing process of this prototype. These included LTH students and Axis employees of ages 23-50. For detailed answers see appendix C. Ideally, a more varied user group would be chosen. Due to the pandemic(COVID19), however, the participants were decided not to include random people.

After each test was completed, the users were asked to rate how easy they found each scenario to perform on a scale of one to five, where one means difficult, and five means easy. This was chosen as a good method to get an overview of each test, and to easily compare the results of different prototypes.

5.6.6 Results and conclusion

The questions asked during the user interviews were:

- **What problems did you encounter?**
- **What worked well?**
- **If you could change anything with this product, what would you change?**

Many of the participants experienced problems by inputting wrong PIN-codes and phone numbers because of slow or lacking feedback. This depended mostly on bugs within Adobe XD, and on limitations of the touch functionality of the smartphone within the prototype. These problems however, mostly showed up with the elder users who were more prone to press harder on the buttons, whereas younger testers had a softer touch and problems with the touch functionality happened a lot less. A touch button lacks the tactile feedback that a physical button provides, and the wide range of different types of touch technologies require different forces to

register touches. With touch interfaces, it is therefore important to use clear feedback to communicate when an action is performed, and what it results in.

A subsequent problem was that several users did not know when a button press was registered, and pressed the same button multiple times. A discussed solution to this problem could be an addition of a progress bar, similar to the ones used when inputting a PIN-code in a smartphone. This can let the users know how many numbers are entered at any point of the process by providing extra visual feedback.

Several users experienced complications with the calling functionality, as they did not expect to have to push the call button twice. These users believed the call would begin when entering the last digit of the phone number. Some users also had concerns regarding the pictograms, not understanding their meanings, or believing they were buttons. The complete results are documented in Appendix C.

The difficulty of every scenario was rated by every participant and can be seen in Table 5.3 below. This shows that very few complications appeared in the use case where an access card is used. The call functionality, however, did not perform well, and is further improved in upcoming sprints.

The Sprint 1 Testing Process				
Scenario	**A**	**B**	**C**	**D**
User:1		4	2	
User:2	5			3
User:3	5		2	
User:4		5	3	
User:5	5		3	
User:6		4	3	
User:7	5			3
User:8		4		3
Average	4,6	4,25	2,6	3

Table 5.3: Table of Testing results from Sprint 1.

To answer the three initial questions of this test:

- **Does the card-sized rectangle indicate where to blip the card?**

  No users experienced problems in where they put the access card. However, the interviews concluded that no one understood the light border as a signifier for this purpose.

- **Does the user have problems figuring out how to use the product in an intended way?**

  Yes, primarily with the call functionality and lack of feedback when pushing buttons.

- **Is the touch pad a good/sufficient solution compared to physical buttons?**

  The touch interface may have caused lacking feedback, which can be improved with physical buttons.

Security Concerns

In discussing the subject of a progress bar with our supervisor at Axis. He mentioned that this has been brought up before within the company. However, Axis have been more interested in keeping the option of using longer PIN-codes, to increase the security. Four numbers is by, a large margin, the most used option, and a possible solution could be to implement a progress bar that can be turned off for longer PIN-codes.

This opens a new discussion about the security aspect of intercoms. Intercoms acts as gatekeepers, and many companies using intercoms are very concerned with the safety of their properties. The weakest link in a security chain is most commonly the human factor, and Human behaviour play an essential role in security flaws (Adams & Sasse, 1999). Therefore it is important to design with Human-Computer Interaction(HCI) in mind when designing a secure system. Hackers often pay more attention to the human link than the actual system in use (Adams & Sasse, 1999). A method used by hackers to figure out security codes is to search for fingerprints on a numpad, and decipher what numbers are used. This is made significantly harder by adding a random extra digit before the actual code, increasing the possible code combinations exponentially. This is a method used to increase the system security, with not much more strain on the user.

5.7 Sprint 2

Since the first sprint is based on the use cases of IP Force, the goal of the second design sprint focuses on the use cases of IP Safety. The main use case of IP Safety is to allow people to get in touch with relevant emergency personnel. Based on this, the long term goal for this sprint is decided to; **Connect people in need with emergency services**.

The Sprint questions are decided as following;

- How do we make sure that people do not use it incorrectly?
- How do we make sure it works when it has to?
- Will emergency services answer in time?
- What if the person in need can not speak?

5.7.1 Map

A new map is created in order to establish the stakeholders and their role in this use case. The map created for this sprint can be seen in Figure 5.12.

Figure 5.12: The Sprint 2 Map.

Another set of HMW-notes are produced and categorised, these can be seen in Figure 5.13 below.

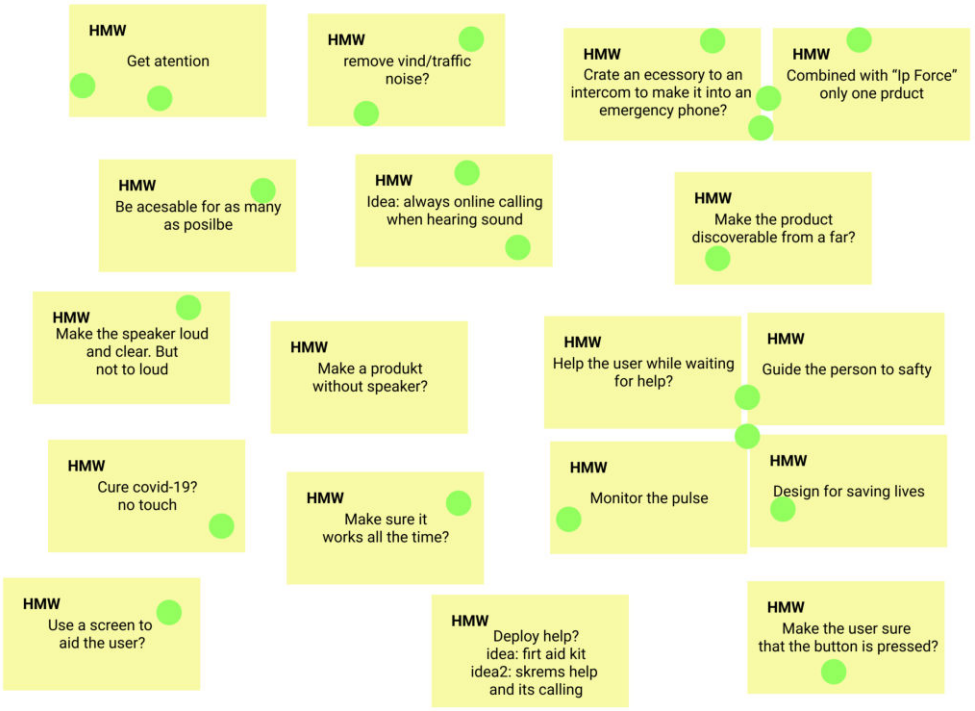


Figure 5.13: HMW Notes in Sprint 2.

Since the use case for this sprint is quite straight forward, this sprint is decided to focus on the whole user experience, from discovering the product to contacting emergency services.

5.7.2 Sketch & Decide

The sketching process begins with a new Lightning Demos-exercise, some examples from this exercise are:

- **Bean bags:**

  Bean bags are products that adapt their shape to fit the user's body. Adapting a product depending on the user's needs is a useful insight.

- **Weighted blankets:**

  Weighted blankets blankets are used to create psychological comfort with the help of physical objects. In the case of a weighted blanket, it is made extra heavy, which creates a calming effect for the user.

The use case in the scenario of this sprint is that a person in need presses a button, and is put in contact with emergency services. The basic functions needed to perform this is already covered by an existing Axis product, Jake. The Four Step Sketching process resulted in an idea that uses this product as a base, and modifies it to fit the the emergency use case. This is done by switching out the face plate of Jake to a new, customised version. The new concept is called Jake Safety. An illustration of this can be seen in Figure 5.14 below.

Figure 5.14: Jake to the Left, Jake without the face plate in the middle and Jake Safety to the right.

Since Jake is an already developed product which fulfils the ruggedness requirements, the idea behind this concept is that a small effort can be made to modify Jake, and create a new product that covers completely different use cases.

Jake is a product that uses a pressure based, numb button, without tactile feedback. This is not suitable for emergency applications since the user's physical abilities may be impaired. Thus, a big mushroom button is used instead. This button can easily be pressed using any body part, and provides extra tactile feedback. The button also lights up to increase the discoverability of the product. A big SOS-label is added above the button to clearly indicate the intended use case. The colour and icon used on the button is further investigated in the prototyping process.

To clarify the steps on how the prototype is meant to be used a storyboard starring Jim is created.

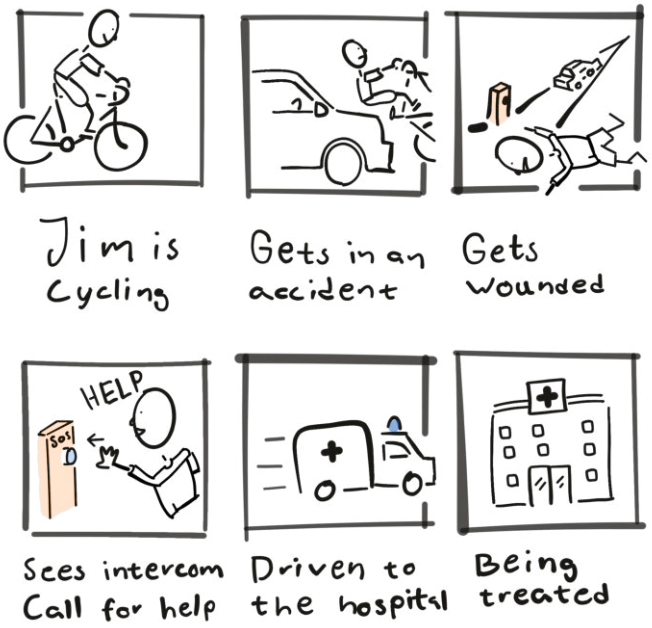


Figure 5.15: The storyboard created for Jake Safety.

5.7.3 Prototype

To make a prototype of this product, a copy of Jake is borrowed from Axis to be used as a base. A new face plate and button is 3d-printed to be placed on top of the product. The button is printed in a semi-translucent material and designed to fit a light, making the whole button light up. A slot on top of the button is also designed to fit a laser-cut and engraved PMMA piece, to be able to easily try out different icons for the button. The prototype assembly can be seen in Figure 5.18 below.

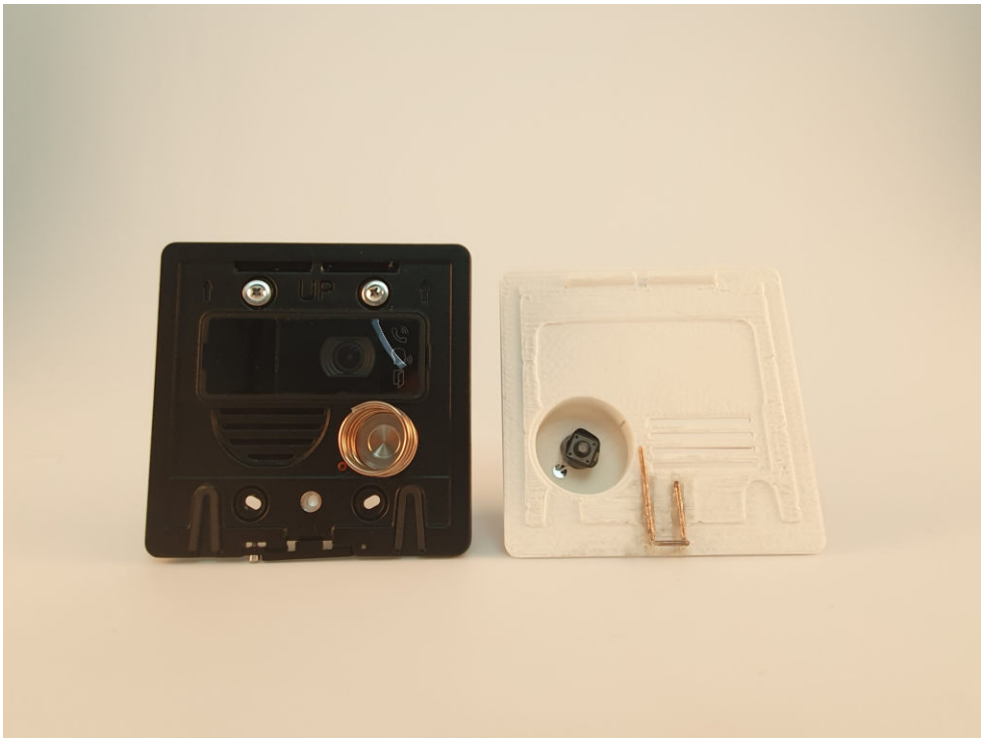


Figure 5.16: Jake to the left. Faceplate of Jake Safety to the right.

Several icons and colour options were tested and discussed with colleagues at Axis (see appendix G for coloring samples). The colour of the new face plate is made orange to be clearly visible. Orange is also a colour commonly used for emergency applications which may cause users to associate the colour with emergency services, which would be beneficial. The icon is chosen to be a blue telephone. The telephone is a conceptual model that explains the function of the button. The blue colour is chosen to create a contrast with the orange and white colours, increasing visibility. Blue is also a colour commonly used for emergency vehicles and healthcare applications, which may indicate to the user where the call is going. The different icon alternatives and finished prototype can be seen in Figure 5.17b and Figure 5.17a below.

(a) Icon testing on the prototype.

(b) Icons in vectors.

Figure 5.17: Icon evaluation.

Figure 5.18: The prototype of Jake Safety assembled.

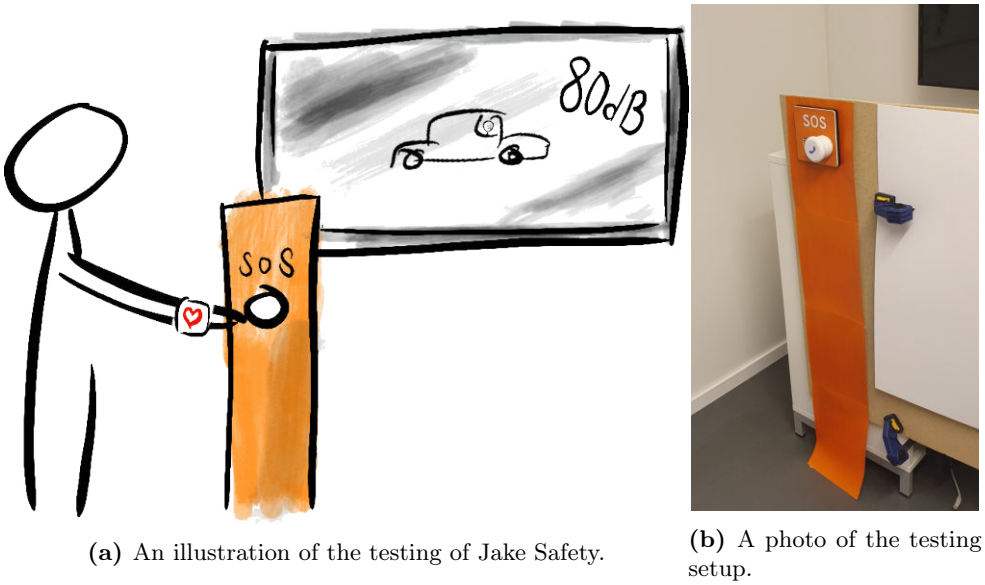
5.7.4 Testing

Some key questions are asked in the beginning of the testing process to conceptualise the aim of the tests before they are performed:

- **Is the speaker loud enough to be heard in noisy environments?**
- **Is it possible for the user to use the product incorrectly?**
- **What problems may arise in the interaction process?**

Since the users' of this product are people in emergency situations, this creates a difficult testing procedure, since these users can not be tested. As an emergency situation is a stressful and adrenaline-releasing experience for the user, a testing procedure to replicate similar effects is developed. This is done by giving every participant a time-based IQ-test before the tests begin, as well as creating a loud and chaotic testing environment. In the testing room, the prototype was mounted next to a television playing a video of a chaotic intersection in Mumbai, India.

Since these types of intercoms are often used on the side of highways, it is essential that the speaker in Jake Safety is loud enough to be clearly heard in these environments. The audio level at these places can reach up to 80 dB (Corbisier, 2003). Thus, the traffic noise of the video was rasied to these levels. The testing environment can be seen in Figure 5.19a and Figure 5.19b below.



(a) An illustration of the testing of Jake Safety.

(b) A photo of the testing setup.

Figure 5.19: Testing environment for Jake Safety.

Once the participants completed the IQ-test they were asked to do the following scenario:

- The user is told that they were hit by a car, and broke both arms. This is done to evaluate how a user operates the button without the use of their hands. They were also told the license plate number of the car to further raise their stress levels. They were then let into the testing room where they had to use the product to contact emergency services. The emergency services were acted by one of the moderators sitting in another room, using a connected intercom.

Seven users were tested in this process. While the ideal participants would be a diverse group, this could not be done due to the on-going pandemic. Consequently, colleagues and classmates aged 25-50 were used. Data was collected during the tests using several methods. Each user's pulse was checked before and after the test to determine if the stress level was increased during the test. They also had to assess their stress level on a scale of one to ten before and after each test. The whole process was observed by a moderator and the users were interviewed after the tests were completed.

5.7.5 Results & Conclusion

Every participant of the testing process managed to complete the task without any greater problems. While no user mentioned that the speaker was not loud enough, many had to lean close to the speaker to be able to hear what was said. This means that a louder speaker is preferred to be used in the future.

Another noticed problem was that some users pressed the button several times because they did not hear the ringtone. This was both because of the loud environment, as well as a lacking ringtone design. The ringtone used in this test is the same as the one used in Jake. The ringtone is using a short ringing sound, with quite a long time between each ring. In addition to using a louder speaker, the ringtone needs revision in the further development. By pressing the button multiple times, the users' unintentionally both started and closed the call. This can be easily fixed by making sure that the call has to be closed from the emergency services.

The stress level of each participant was raised by an average of +2,071 points during the testing process. While this shows that the stress level was raised, the pulse remained at almost the same heart rate as before. In further development of this product, more thorough research have to be made about these kinds of tests. The complete results from stress, and heart rate monitoring is showed in Table 5.4 below and for detailed notes from the testing process can be seen in appendix D.

Sprint 2 Testing Results						
Scenario	**(Stress) Before**	**(Stress) After**	**Diff**	**(Pulse) Before**	**(Pulse) After**	**Diff**
User:1	1	1	0	72	74	+2
User:2	4	7	+3	77	86	+9
User:3	3	5	+2	87	81	-6
User:4	2,5	7	+4,5	84	81	-3
User:5	6	8	+2	95	100	+5
User:6	2	4	+2	81	84	+3
User:7	5	6	+1	80	84	+4
Average	3,357	5,42	+2,1	82,285	84,285	+2

Table 5.4: Table of Testing results from Sprint 2.

5.8 Sprint 3

With all use cases of IP Safety and IP force covered by the two previous sprints, the third sprint is decided to focus on the use of physical buttons, and its usability aspect compared to capacitive touch buttons. The sprint begins with the decided long term goal: **Make an intuitive intercom with physical buttons**

The sprint questions are decided as:

- **How do we make tactile and rugged buttons?**
- **How can we create a modern-looking product with physical buttons?**
- **How is a physical button product clearly designed?**

5.8.1 Map

This sprint again focuses on the use cases of IP Force. The map from sprint one (see Figure 5.5) is therefore reused for this sprint since the same actions and stakeholders are included.

5.8.2 How Might We Post-it

A new set of HMW-notes are created to draw attention to problems and concerns surrounding the use of physical buttons in an intercom. These can be seen in Figure 5.20 below.

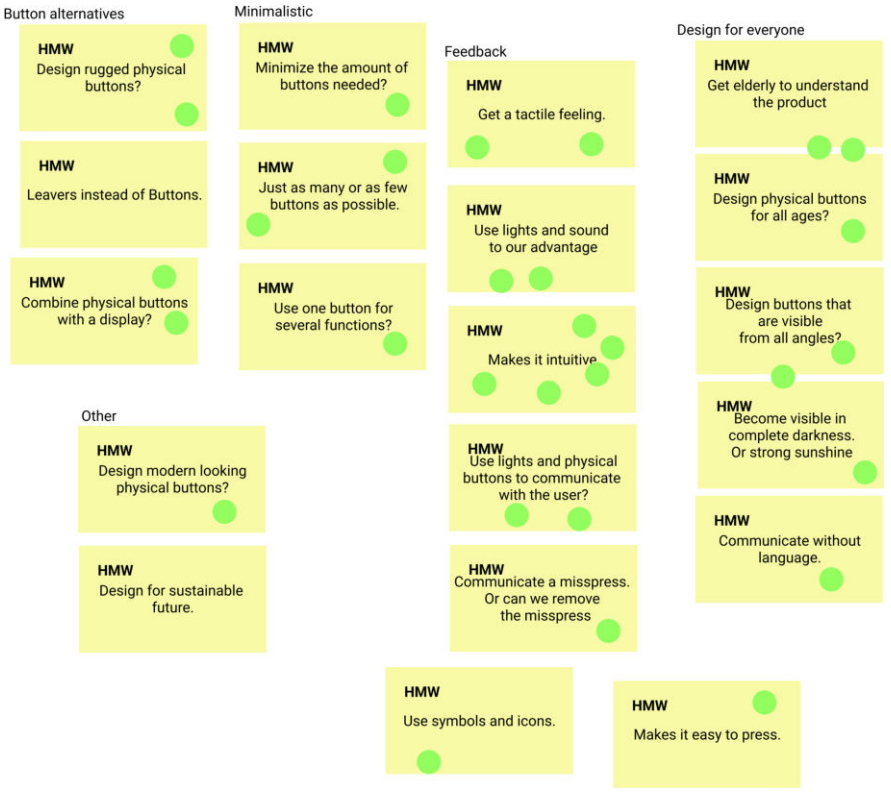


Figure 5.20: HMW Notes in Sprint 3.

5.8.3 Sketch & Decide

The sketching process is initiated with Lightning Demos. Some examples of these are:

- **Haptic buttons in smart phones**

  Some smartphones have used haptic buttons as home buttons. This is not an actual physical button, but uses touch functionality and a vibration motor to give the user tactile feedback.

- **Light switches are angled buttons**

  Light switches are usually designed with an angle. This creates an interesting type of feedback as the control itself changes.

During the sketching process an important realisation is made (see appendix B) for sketching material. The sketched concept deemed most suitable for these use cases, works, and looks, like the prototype Barbro in most aspects. With the main difference being the use of physical buttons. While building this concept, and comparing it to Barbro, would be an interesting and learning experience, this sprint is altered at this point. Building a useful prototype to test out the usability of physical versus touch buttons is deemed too time consuming.

Instead of building and testing a prototype, research on this subject is performed.

5.8.4 Touch versus physical buttons

Two main alternatives exist as the interactive medium of an intercom; physical button and capacitive touch sensors. They both have their advantages and disadvantages, both from an interactive design and a ruggedness perspective. The ruggedness aspect is complex and needs further research in the continuing development of these products, and is not further investigated here.

From an interaction design perspective, a physical button interface has the unique capabilities of vision-free use cases. The tactile feel of physical buttons make them easier to find and use than touch interfaces. The physical feedback of a clickable button also gives clear feedback of when a press is recorded, in the form of a tactile click (Lee & Zhai, 2009). Because of a physical interfaces' extra feedback, an interface using smaller physical buttons can be produced with the same usability as a touch interface with the same layout (Centre for Excellence in Universal Design, 2013). This is important when space is limited.

In a usability study of In-Home-Displays, with a similar user demographic, size, and height placement as intercoms, most users preferred the use of physical button, compared to dials or touch controls. This was especially true for older people who experience difficulties with dexterity and precision (Centre for Excellence in Universal Design, 2013).

A study comparing physical and touch button usability in handheld devices, however, showed equal or better performance for touch buttons. This study also revealed that the use of aural feedback did not increase performance of physical buttons, while they significantly did so for touch buttons (Lee & Zhai, 2009). This indicates that multisensorial feedback is beneficial, but using feedback aimed towards more than two senses lead to no further performance icrease.

5.9 Sprint 4

Because users experienced some difficulties in the testing process of Barbro(see section 5.6), the fourth sprint focuses on further developing this concept. When a concept is iterated in the design sprint, the first step of the process can be reused (Knapp et al., 2016). This means that the long term goal, map, HMW-notes and Lightning Demos from Sprint 1 are again used to form the basis of this sprint. The main goal of this sprint is to fix the problems of the concept Barbro. A quick recap of the problems discovered in the tests of this concept are described below.

Some users experienced problems with the action sequence of the call functionality, since the phone button have to be pressed twice. Another problem was that many users did not receive sufficient feedback when pressing buttons. This was originally determined to be caused by bugs within the prototype. In further evaluation of this problem, however, it was discovered that the users' fingers were covering the button completely, blocking the visual feedback of a flashing button. A subsequent problem was that users got lost in the action sequence since they had no indication of how many numbers they had pressed in a PIN-code or phone number. The last discovered problem was that some users thought that the pictograms were buttons.

5.9.1 Sketch & Decide

To design the new concept of the product, a decision is made to let the user interface and its usability determine the size of the product to not compromise the user experience because of size limitations. When using touch-based input on a device, it is recommended to use a minimum button width, greater than the size of the 95^{th} percentile male index finger (ISO 9241-410, 2008) which measures 21mm (ISO/TR 7250-2, 2010). Spacing between buttons should be at least 2.5mm (Centre for Excellence in Universal Design, 2013). These recommended measurements are used for this concept to ensure effectiveness and reduce the risk of error.

To evaluate whether to use square or circular buttons, a short study is developed to test the performance of each alternative. The test is also using the chosen button measurements to evaluate the button size.

In the testing process, each user is given a task of pressing a sequence of 18 numbers on a numpad. The user is told to press the number with a red button, which changes after each button press. The user interface for created for this test can be seen in Figure 5.22 below.

Figure 5.21: The user interface developed for testing out button shapes.

Every participant performed four different testing sequences. Two with round buttons and two with square buttons. During the test, every sequence was timed and any mistakes made were noted by a moderator. The results from these tests can be seen in Table 5.4 below.

Square vs Round Testing Results						
Test	**Time A,1**	**Time A,2**	**Average**	**Time B,1**	**Time B,2**	**Average**
User:1	9,23	10,74	9,985	9,30	9,10	9,2
User:2	11,14	11,10	11,12	12,06	11,19	11,625
User:3	10,01	8,24	9,125	9,88	9,02	9,45
User:4	10,20	10,00	10,10	9,95	9,85	9,90
Average	10,145	10,02	10,08	10,30	9,79	10,04

Table 5.5: Square vs Round Testing Results.

Every user completed the test without making any mistakes, and the average time difference between round and square buttons amounted to only four milliseconds. Even though the scope and range of this test is limited, a conclusion is made that the shape of this size of button does not affect its performance. It is also concluded that the button size and layout works well since no unintentional button presses were recorded. A decision is made to use round buttons since space between the buttons can be used for a card reader symbol. Further design choices are motivated in the prototyping section (Section 5.9.2).

5.9.2 Prototype

The prototype is created in a completely digital format in order to save time. Since the prototype is developed for an Ipad, and the interactive medium of the intercom also is touch-based, this method of prototyping is concluded to be sufficient. To add realism to how the actual product would look, the prototype is made to look like it is recessed into a brick wall. The finished prototype is called Berit and can be seen in Figure 5.22 below.

Figure 5.22: The digital prototype Berit.

5.9.3 The User Interface

Because of the choice to use circular buttons, two signifiers are allowed to be placed in the middle of the interface to indicate to the user where they are supposed to put their access card. These symbols are based on similar symbols used to indicate where to put a credit card in order to make a transaction.

The previous prototype, and almost every other intercom uses a numpad with a $\star$ and #-symbol. These are remnants of numpads used on actual telephones, and are often not used at all. They are therefore removed for this prototype and replaced with a telephone and X-icon(see figure 5.22). The telephone icon is the same as previously used. The X-icon is introduced to give the user the option to cancel an interaction at any given time. For instance, if a number is unintentionally pressed.

Two other new functions include a progress bar and a camera status indicator. The progress bar uses four adjacent LED-lights showing the user how many numbers are currently inputted when entering a PIN-code. The camera status indicator is a single LED-light located next to the camera, that lights up once the camera is in use. This is used to indicate to the user when they are being filmed. These functions can be seen in Figure 5.23 below.

Figure 5.23: The progress bar and camera status indicator.

Colour theory in interaction design can be complex since the meaning of colours is based on cultural context. Consequently, different colours can have completely contrasting meanings in different parts of the world (Interaction Design Foundation, 2017). Some colours, however, are globally used for the same purpose. Both red and green are universally used in traffic lights to indicate whether to go, or stop (International Driving Authority, 2017). These colour options are chosen to be used in a similar fashion in this prototype.

Red is used for the cancel-button to indicate that it stops, or resets the current action sequence. If a user inputs a wrong code or does not have access to the particular door, the light border and progress bar flashes in red to indicate that the door did not open. This is combined with an error-sound to give the user two types of feedback. Green is similarly used to indicate when the door is unlocked. It is also used in the call-button to signify that it starts a call. Since the pictograms of the previous prototype were confusing to some users, they are now removed from this prototype. The colours used are deemed sufficient to provide enough feedback to the users. These colour uses can be seen in Figure 5.24 below.

(a) The light border and progress bar flashes in red when a code is incorrectly inputted.

(b) The light border and progress bar flashes in green when the door is unlocked.

Figure 5.24: The different colour uses of Berit.

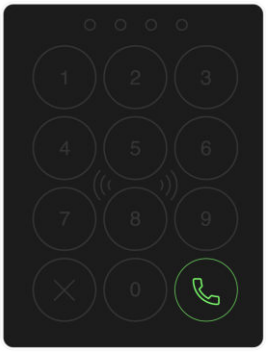
Throughout the action sequence, continuous feedback is provided by flashing the pressed buttons and playing a beeping sound to notify the user that an action is performed.

The user interface is designed to accommodate every possible way to interact with the product. In previous tests, some users wanted to press the call-button first, and the phone number after, while others preferred the inverse. Thus,

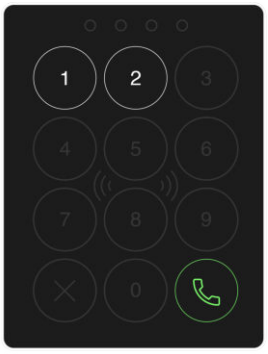
this prototype is developed so both methods can be used.

Designing for configurability

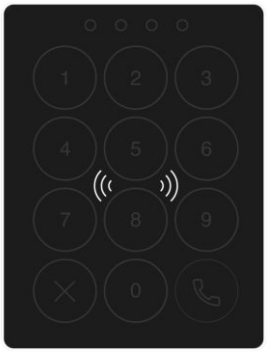
This product is based on the intercom IP Force that currently exists in 15 different configurations. These configurations exist to give the customer more freedom to adapt the product to their actual use case. This prototype is designed with the same configurability in mind, but instead uses software changes to adjust the user interface to fit the user's needs. Some example configurations of this can be seen in Figure 5.25 below.



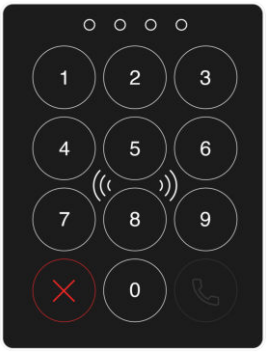
(a) UI for when only one calling destination is needed and no access card functionality is used.



(b) UI for when two calling destinations are needed and no access card functionality is used.



(c) UI for when an access card is used without a security code, and no calling functionality is used.



(d) UI for when an access card is used with a security code, and no calling functionality is used.

Figure 5.25: Different user interface alternatives.

5.9.4 Test

The testing process begins with a couple of questions to clarify the aim of the test:

- Does the new signifier clearly indicate where the access card should be placed?
- Does the new call functionality work intuitively?

- Will the bigger user interface and buttons fix the problem of lacking feedback?
- Will the progress bar aid the user in recognising the current state of the intercom?
- Will the removal of pictograms make the product less understandable?

For each test, an Ipad running the digital prototype is mounted on a wall next to a door, 1.3 meters above the floor. The user is then tasked to unlock and enter the door by using the intercom. The test setup can be seen in Figure 5.26 below.

Figure 5.26: The testing setup for Sprint 4.

Four testing scenarios were created with the intention of testing two scenarios on each participant. Each user tests a scenario for both the access control, and call functionality of the intercom. The order in which the scenarios are performed is altering for different participants to eliminate the risk that the user might get more familiar with the device, changing the results. The different scenarios are described below.

(A) The user should call into the building using the configuration of the UI where no number is needed.

(B) The user should call either a reception or warehouse using a configuration of the UI with two calling destinations.

(C) The user should unlock the door by using an access card and entering a PIN-code, either 1433 or 5093.

(D) The user should unlock the door by using an access card that works without a PIN-code.

The initial state of the prototype for each scenario can be seen in Figure 5.27 below.

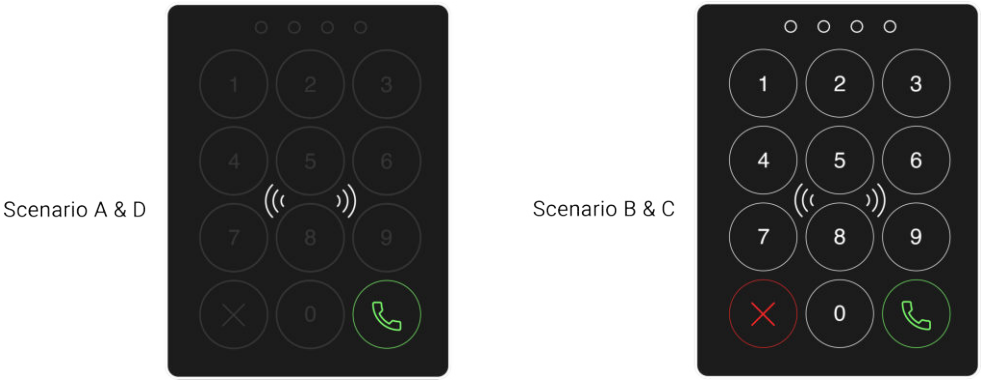


Figure 5.27: The initial state of the prototype.

Older users are more likely to experience difficulties in the interaction process due to degradation of physical abilities like dexterity, sight, and hearing. Thus, extra effort is made in this testing process to include a user group with a more varied age span. Nine users between the ages of 21 and 86 participated in the testing process of this prototype. After each test was completed, the users were again asked to rate how easy they found each scenario to perform. This is done to be able to compare the results of this prototype with Barbro. A brief semi-structured interview was conducted after each test to receive additional information about the users' experience (see appendix E for detailed notes from each test).

5.9.5 Results & Conclusion

Finding a good signifier representing where to place the access card was significantly harder than anticipated. Two users stated that the used symbol looked like a Wi-Fi or ringtone symbol. Only one user, however, placed the access card incorrectly. Another discovered problem was that some users tried to enter the PIN-code before using the access card. This is easily fixed by modifying the software to allow this interaction process as well. No user experienced issues with missed inputs or lacking feedback, indicating that the feedback issues of Barbro are resolved. This is probably the result of using bigger buttons and the addition of a progress bar. In some cases, customers want to use PIN-codes longer than four digits. This could be solved by adding more LEDs to the progress bar, and modifying the software to adjust the amount of LEDs used in the progress bar to match the length of the PIN-code.

All users correctly assessed when the door unlocked and when a call was accepted, indicating that the provided feedback is sufficient and that the removal of pictograms did not negatively affect the product. The camera indicator was not noticed by any of the users since their focus was on the numpad. This is a feature that have to be further evaluated in the future. The results of the participants' assessed difficulty rating can be seen in Table 5.6 below.

Difficulty ratings of Berit				
Scenario	**A**	**B**	**C**	**D**
User:1	2		5	
User:2		4		3
User:3			3	5
User:4		5	2	
User:5	4,5		5	
User:6		5	4	
User:7		5	5	
User:8		5	5	
User:9		5	4	
Average	3,25	4,833	4,125	4

Table 5.6: Testing results (1=Hardest, 5=Easiest).

These results do not demonstrate a perfect product, but it scores far higher than the previous prototype Barbro. Furthermore, three of the users who experienced difficulties completing scenario C, did so because they began the process by inputting the PIN-code before placing the access card. As previously mentioned, this is easily resolved by allowing this action sequence as an alternative method. By also including older people in the user group, an indication of its usability for elderly is shown. However, further tests have to be made to confirm this result.

Chapter 6

Final Prototypes

By using a Human-Centred Design process and the Design Sprint methodology, two final prototypes have been developed to cover the use cases of IP Force and IP Safety, and their 18 different configurations. The system requirements established in Section 5.5 are adjusted and divided into two different products. The details of how to achieve many of these requirements will have to be further evaluated in the future as they are not investigated in this thesis. The developed prototypes are presented below.

6.1 Berit

Berit is a rugged intercom designed to cover the use cases previously covered by IP Force. This means that it should be able to unlock a door either by using an access card or by calling a person within the building who remotely unlocks the door. To adapt to the different configurations that exist for IP Force, this product is configurable by software to adjust its functionality depending on the situation. It is designed with a card reader, capacitive touch numpad and call functionality to cover these use cases.

Compared to other intercoms, Berit uses larger buttons to reduce the risk of error and ensure that the feedback provided is not compromised by blocking the buttons. The use of bigger buttons also allows for the use of larger numbers, making the product easier to use for people with impaired vision. The use of universally acknowledged colour theory is implemented in a light border surrounding the numpad that flashes to indicate when the door is unlocked or when an action has failed. Every action is provided with

multisensorial feedback and uses both aural and visual feedback to always alert the user whether an action is successful. The confusing $\star$ and #-symbols are replaced by a cancel and call-button. A progress bar is placed above the numpad to increase the discoverability of the intercom, making sure that the user always can determine how many numbers are inputted in a PIN-code.

The finished prototype can be seen in Figure 6.1 and Figure 6.2 below.

Figure 6.1: The finished prototype of Berit.

Figure 6.2: A renderering of Berit placed outside a warehouse entrance door.

6.2 Jake Safety

Jake Safety is a rugged emergency intercom designed to cover the use cases previously covered by IP Safety. It allows for people in emergencies to contact emergency services in order to receive the needed help.

Compared to other emergency intercoms, Jake Safety is designed with a big mushroom button to ensure that it is usable by anyone, regardless of their physical capabilities. The mushroom button allows the user to press it with any body part. It also lights up to increase discoverability and provide extra feedback when it is pressed. The colour of the face plate is made orange to increase visibility and indicate that it is an emergency device. A big SOS symbol is put on top of the device to signify the product's use case and a blue telephone icon is put on the button to signify its function.

A big advantage of Jake Safety is that it is based on an already existing Axis product, called Jake. Jake Safety uses the technology and components of Jake, but switches out the front steel plate. This allows Axis to create a new product with relatively low effort and cover a complete new use case. The finished prototype of Jake Safety can be seen in Figure 6.3 and Figure 6.4 below.

Figure 6.3: The finished prototype of Jake Safety.

Figure 6.4: A renderering of Jake Safety placed by a road.

Chapter 7

Discussion

7.1 Condition for thesis

From the early stages in this process, it was a balancing act between creating a rugged product, and focusing on the interaction design aspect to create an easy-to-use product. The initial thought was to keep both highly prioritised. During the process, however, we realised that to thoroughly investigate the ruggedness aspect of these intercoms, makes up an entire master thesis on its own. We therefore decided to mainly focus on the interaction design aspect. Different interactions and discussions with co-workers and the product owner at Axis also affected where the thesis would be heading.

The goal and desired outcome for this thesis was not clear in the beginning of the project, but was gradually formed as the thesis developed. Because of this, no delimitations were established in the beginning of the process, causing the initial scope of the project to include the development and redesign of two different products (IP Force and IP Safety). This eventually led to two different product development processes. It may have been better to focus on only one of these products, to be able to focus more attention, thus creating a better end product. The already existing intercom Jake also caused a bit of confusion since it in many ways already had covered some of the use cases of IP Force.

An area that would be interesting to investigate further is the implication and use of different sounds used for feedback. Another interesting field would be the use of alternative identification methods such as biometrics.

Throughout the timeline of this thesis, the world has been considerably affected by the ongoing pandemic(COVID19). This affected us primarily by not allowing the usability studies to include as large, or as diverse user groups as required for a correctly executed testing procedure.

7.2 Process

The methodology used in our interaction design development process combines the use of Human-Centred Design and Google Ventures' Design Sprint. These tools worked well together since they combine the effectiveness and iterative nature of the Design Sprint with the thorough and more complete Human-Centered Design methodology, which has been validated through years of application and is recommended by the International Standards Organisation (ISO 9241-410, 2008). The Design Sprint alone would not have been enough to deliver the results presented in this thesis since it describes the form of a creative design process, but does not go in to the specifics of how to develop a product that is intuitive and easy-to-use. These methods therefore complemented each other. The Sprint Design methodology is developed to be used in larger teams. While it still works used by two people, many steps of the process had to be adjusted. To fully utilise the method, a team consisting of experts from varying fields should be assembled.

A key difference with the Human-Centred Design and the Design Sprint methodology is that Interaction Design emphasises on first creating Lo-Fi prototypes, and then producing a Hi-Fi prototype of the same concept, whereas the Design Sprint directly focuses on producing realistic prototypes. Interaction Design includes the use of Lo-Fi prototypes because realistic prototypes do not always implicate more realistic test results. Hi-Fi prototypes may cause the users to focus on superficial details in the prototype, rather than on the interaction process itself. Hi-Fi prototypes can also cause users to change their approach to the product as the prototype looks more like an actual product(Rogers et al., 2011).

7.3 Results

The results of this thesis can be divided into the results of each particular sprint, since different results and conclusions were discovered. One general major limitation, however, was the lack of access to a diverse group of test

users. Almost all users in the tests performed in this thesis were either Axis employees or students at LTH, all of whom had experience in using intercoms or access control devices before. A majority of these users were also below the age of 30. This is not a user group representing the complete intended user base. The average user would most likely struggle more with these prototypes. Thus, further tests will have to be made to confirm the results shown in this thesis.

7.3.1 Sprint 1

Sprint 1 resulted in a concept not unlike one of Axis own products. While this concept exhibited a lot of problems during the testing process, a lot was learned and big changes were made in the further development of this product. The long term goal was decided to **Make intercoms easier to use**. This goal was probably not achieved in this sprint.

7.3.2 Sprint 2

Sprint 2 resulted in a promising concept in the form of a modification to an already existing Axis product. The tests of this prototype showed promising results, with every participant completing the test without any greater problems.

During the testing process, we tried to raise each participants stress level to imitate the state of mind of a person in danger. We measured every participants pulse before and after the test to evaluate how stressed each participant got. While the pulse was generally only raised marginally, we also asked the participants how stressed they felt before and after the test, and noticed a bigger difference. However, since the users tested were not in actual danger, their performance may be completely different from the actual users. This will also have to be further investigated in the continued development of this concept.

This prototype shows extra potential since a relatively small effort can be made to produce a completely new product. This is possible because a vast majority of the products components are reused from an already developed product.

7.3.3 Sprint 3

While the third sprint did not result in a new prototype, the research performed on physical versus touch buttons led to some useful insights. The difference in usability between physical buttons and capacitive touch sensors was discussed and analysed. It was concluded that no solution is objectively better than the other, but depending on the situation, each alternative have their advantages and disadvantages. If the size is limited, better performance is achieved by using physical buttons. However, if you allow the user interface to use more space, capacitive touch buttons can perform better than physical buttons(Lee & Zhai, 2009).

7.3.4 Sprint 4

The fourth sprint also had the long term goal **Make intercoms more easier to use** as it was based on Sprint 1. The testing process exhibited promising results since no user experienced problems with either the button size or touch functionality. One of two discovered problems was that some users did not understand the symbol for the card reader. The card reader symbol will have to be further investigated to create an optimal solution. The other noticed problem was that three users tried to enter the PIN-code before using their access card. This can be resolved by either modifying the software to allow for this interaction as well, or modifying the software to make the access card activate the display, physically constraining the user to use the access card first. This will have to be further evaluated in the future development of this project.

This concept is considered a success since it managed to combine all of the use cases of the different configurations of IP Force into a single product, and the testing process concluded that with some minor tweaks, no users would find it difficult to use. It is also an adjustable product that can be tailored to fit the specific needs of each customer. Since this can be done completely by modifying the software, no extra resources have to be spent in producing more parts or keeping extra inventory, as was previously the case for IP Force.

7.3.5 The use of touch screens

A subject that was regularly discussed during the development process, and something that ideally would be developed and tested in this thesis, is the use of touch screens as the interactive medium of an intercom. A touch screen allows for a completely adjustable user interface. This enables functions like

contact lists, settings, and menus to be included in the intercom. These are all functions that may improve the user experience.

The downside of using touch screens, however, is that they are more expensive, and substantially more difficult to make rugged. This thesis partly aimed to investigate if it is possible to produce the same usability performance, using capacitive touch buttons, as using a dynamic touch screen. Since no touch screen intercom was developed in this project, no certain conclusions can be made. Nevertheless, the prototype developed in Sprint 4 showed promising results, that may indicate that a capacitive touch solution is sufficient. This will have to be further evaluated and tested to be confirmed however.

This approach also allowed the use cases of several different configurations to be combined into a single product. While discussions early on in the project included a vision to have a single product that could fulfil the use cases of both IP Force and IP Safety. These use cases were too different to accommodate for all the use cases in one product.

Chapter 8

Conclusion

As mentioned in the introduction of this report, the aim of this thesis was to evaluate and analyse two existing intercom's designs, use cases and market potential and redesign them to fit Axis portfolio and quality standards. Since the scope of this project was quite large, we decided to focus on the interaction design aspect, since it is an area we believe is heavily under valued in many companies. This resulted in two intercoms that were, according to the performed usability tests, quite easy to use. To better envision what we were trying to examine with this project we asked the following questions, which we will try to answer and reflect upon here.

- **What makes an intercom intuitive and easy to use?**

  Early on in this report, we referenced doors as examples to show the importance of considering interaction design within product development. Doors, however, are quite simple in their interactions, since there are usually just a couple of possible actions. It became clear that a product such as an intercom, with a lot more complexity than a door, becomes exponentially harder to design in a way that suits everyone.

  A product's usability is hard to assess, since it depends on every user's different background. But we still could make some key takeaways from our process that we believe are useful for all intercoms:

  - **Size**

    The size of the product heavily influences its usability since the size

of the product directly affects the size of the user interface. And we noticed during our process, that it is essential to allow every item in the user interface(buttons, icons, text etc) their proper space, to avoid misinterpretation and misuse.

- **Feedback**

  Another aspect that we learned was very important is the feedback given from a product. Without sufficient feedback, again, misuse and misinterpretation became apparent.

- **Discoverability**

  We also noticed the importance of designing with discoverability in mind. From the usability testing, we noticed several problems because of poor discoverability. For example, we had problems with users trying to use their access card before entering a PIN-code because the user received no indication that the card was supposed to be used first.

- **How can we design an easy-to-use intercom?**

  Many different methods and processes have been developed for the sake of designing intuitive and easy-to-use products. Since there is no objectively correct way of designing a product, many of these methods can work. But there are some aspects that we believe are essential for the overall success of a product.

  - **Prototyping**

    Prototypes can be useful both as high or low fidelity types. But we believe that creating good prototypes, that lets the users test a version of the product that gives the experience of a finished product. Bad prototypes may cause users to experience things that they would not have experienced in the real product, and the focus for improvements can thus be less than ideal.

  - **Usability testing**

    Testing the prototypes with a well organised and planned testing procedure is key. A product designer can easily have a prejudiced image of a product, which does not correlate at all with actual users. It is therefore very important to properly test the products to evaluate what works and what does not, before any expensive

commitments have been made.

- **Iteration**

  We also believe that iteration is one of the most important aspects in creating good products. Designing a perfect and intuitive product on the first try is next to impossible. And every time you go through the different phases of product development, new ideas emerge and new lessons are learned. This became apparent in our process as our final prototype performed far better than our first one.

- **How can companies benefit from an interaction design focused product development process?**

  This is a difficult question for us to answer, since we did not actually compare an interaction design focused product development process with another one. What became apparent, however, was that the products we created gradually became better with every iteration, and we believe that the process was key in succeeding with this.

  The International Standards Organization describes Human-Centered Design as an approach that has significant social and economic benefits for users, employers and suppliers(ISO 9241-210, 2010). This is something we believe as well.

8.1 Recommendations for further development

For the further development of these concepts, we recommend to more thoroughly investigate how a touch screen and physical-button alternative would compare against Berit. We also recommend further expanding the tests made on Berit to verify the results. When these three alternatives are compared, a truly informed decision can be made to decide whether the extra cost and effort to produce an intercom using a touch screen is worth the investment. Or if a capacitive touch version is sufficient.

For Jake Safety, further testing is also recommended as its testing process also lacked a proper user group. Nevertheless, because of its promising results, and the relative little effort required to make it into reality. We believe this concept has potential and purpose, to become an actual product.

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Appendix A

Use cases for IP Force and IP Safety

HD Camera with one Button - IP Force

One button for calling one recipient like reception or security guard. The camera is used for authentication. The operator can remotely open a door/gate/barrier which can be connected directly to the intercom.

No Camera with one Button - IP Force

One button for calling one recipient like reception or security guard. The operator can remotely open a door/gate/barrier which can be connected directly to the intercom. In those installations it is not permitted to have a camera due to integrity reasons. (example återvinning)
Sometimes cost sensitive installations (product without camera is cheaper)

HD Camera with four Buttons - IP Force

In some installation one button is not enough. For example, office buildings with different companies or when more than one recipient is expected to get a call. The camera is used for authentication. The operator can remotely open a door/gate/barrier which can be connected directly to the intercom.

No Camera with four Buttons - IP Force

In some installation one button is not enough. For example, office buildings with different companies or when more than one recipient is expected to get a call. The operator can remotely open a door/gate/barrier which can be connected directly to the intercom. In those installations it is not permitted to have a camera due to integrity reasons.
Sometimes cost sensitive installations (product without camera is cheaper)

HD Camera with two Buttons and one reader - IP Force

If you are a member of a facility or an employee, you will have an access card. A reader in the intercom is here used as a device to authenticate. If you are a visitor or have lost your card you should have an option to call an operator or info line for example. The operator can eventually authenticate your face through the camera to grant access.

Figure A.1

No Camera with two Buttons and one reader - IP Force

If you are a member of a facility or an employee, you will have an access card. A reader in the intercom is here used as a device to authenticate. If you are a visitor or have lost your card you should have an option to call an operator or info line for example. A camera in this use case could be either prohibited or not necessary as the operator would not have a device to authenticate the face of the dialer.
Sometimes cost sensitive installations (product without camera is cheaper)

HD Camera with one Buttons, one reader and pictograms - IP Force

This use case adds pictograms to show the current state of a call. This is in certain parts of the world (France, Austria,...) a requirement for public installations. One button is enough for calling one recipient but also here a card reader can be used for access control purposes. The camera here is needed for authentication or video surveillance.

No Camera with one Buttons, one reader and pictograms - IP Force

This use case adds pictograms to show the current state of a call. This is in certain parts of the world (France, Austria,...) a requirement for public installations. One button is enough for calling one recipient but also here a card reader can be used for access control purposes. A camera in this installation might be not prohibited.
Sometimes cost sensitive installations (product without camera is cheaper)

HD Camera with one Button and keypad - IP Force

Instead of a card reader a keypad can be used for entering a PIN or mobile phone number (short numbers i.e. 123). The camera is then used for authentication.

No Camera with one Button and keypad - IP Force

Instead of a card reader a keypad can be used for entering a PIN or mobile phone number (short numbers i.e. 123). No camera is allowed
Sometimes cost sensitive installations (product without camera is cheaper)

Orange - No Camera with one button - Ip Safety

One button for emergency situations (traffic highway etc.)

Orange - No Camera with one mushroom button - Ip Safety

One mushroom button for emergency situations where the button needs to be red and easily accessible (underground station)

Orange - No Camera with two buttons (INFO and SOS) - Ip Safety

Two buttons for two use cases (INFO or SOS)

Figure A.2

Appendix B

Sprint 3 sketches

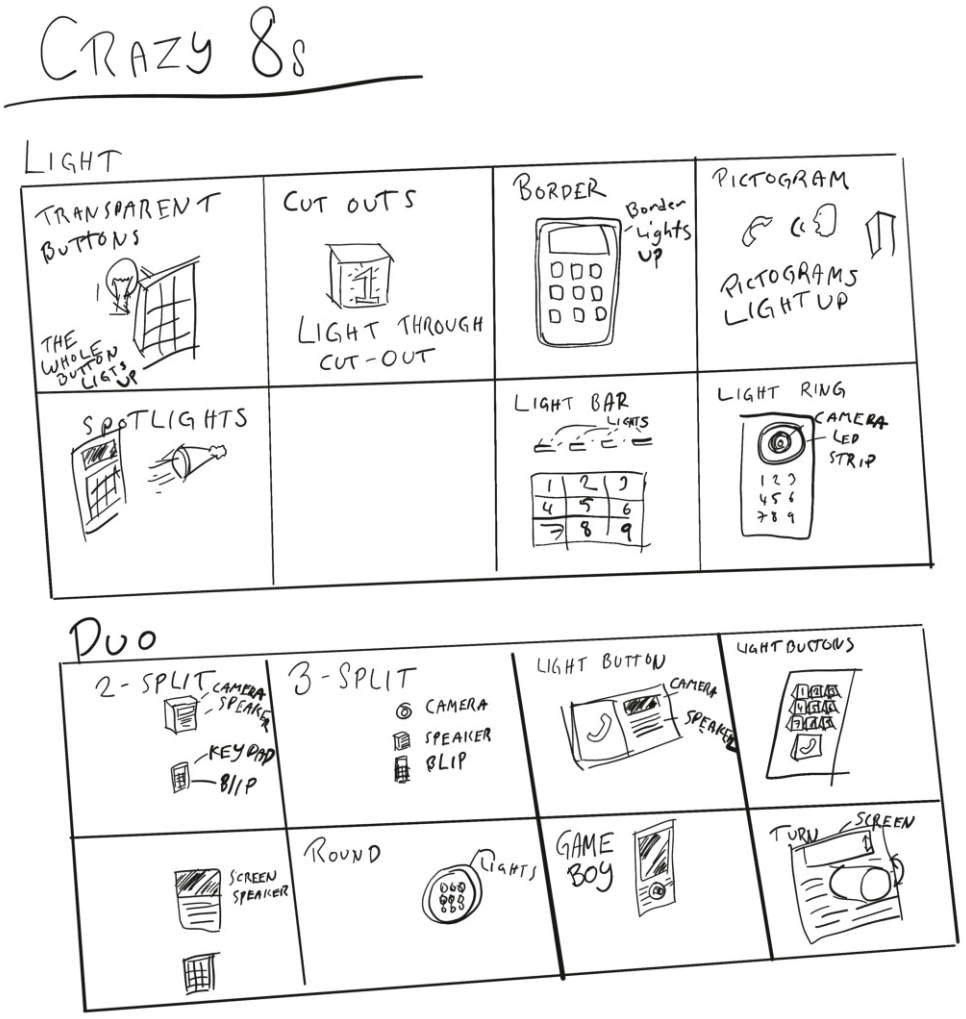

Figure B.1: Crazy Eights

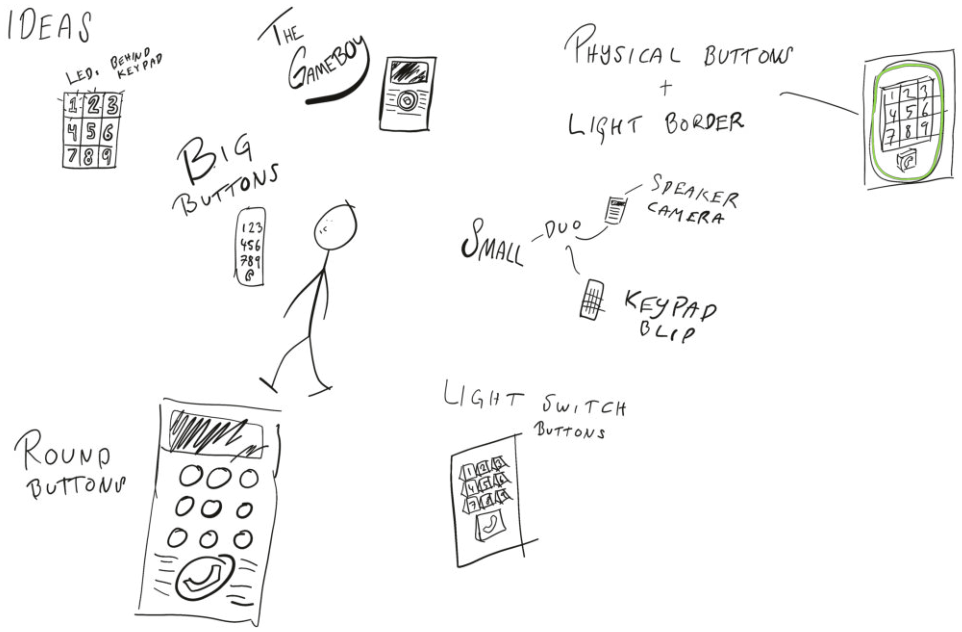

Figure B.2: Ideas

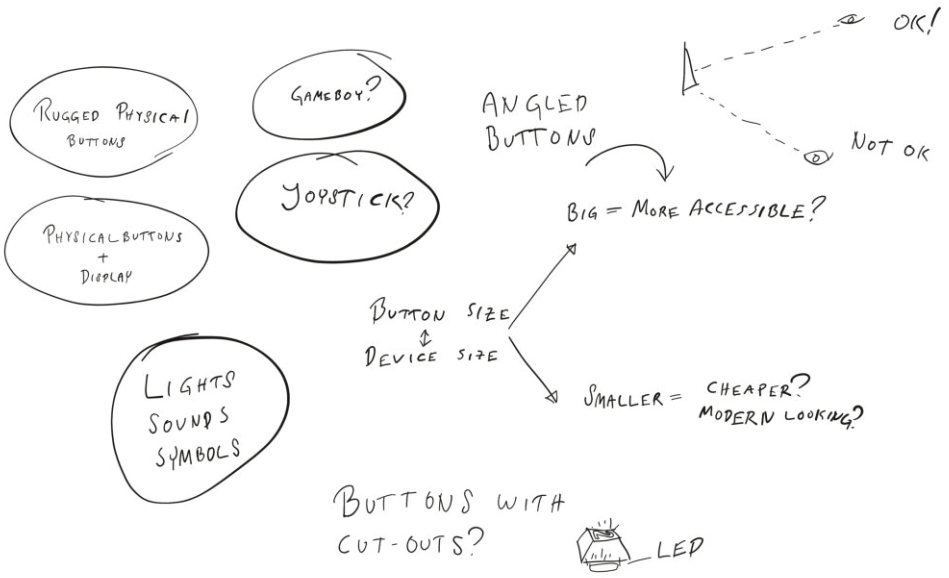

Figure B.3: Ideas

Figure B.4: Lightnings Demos

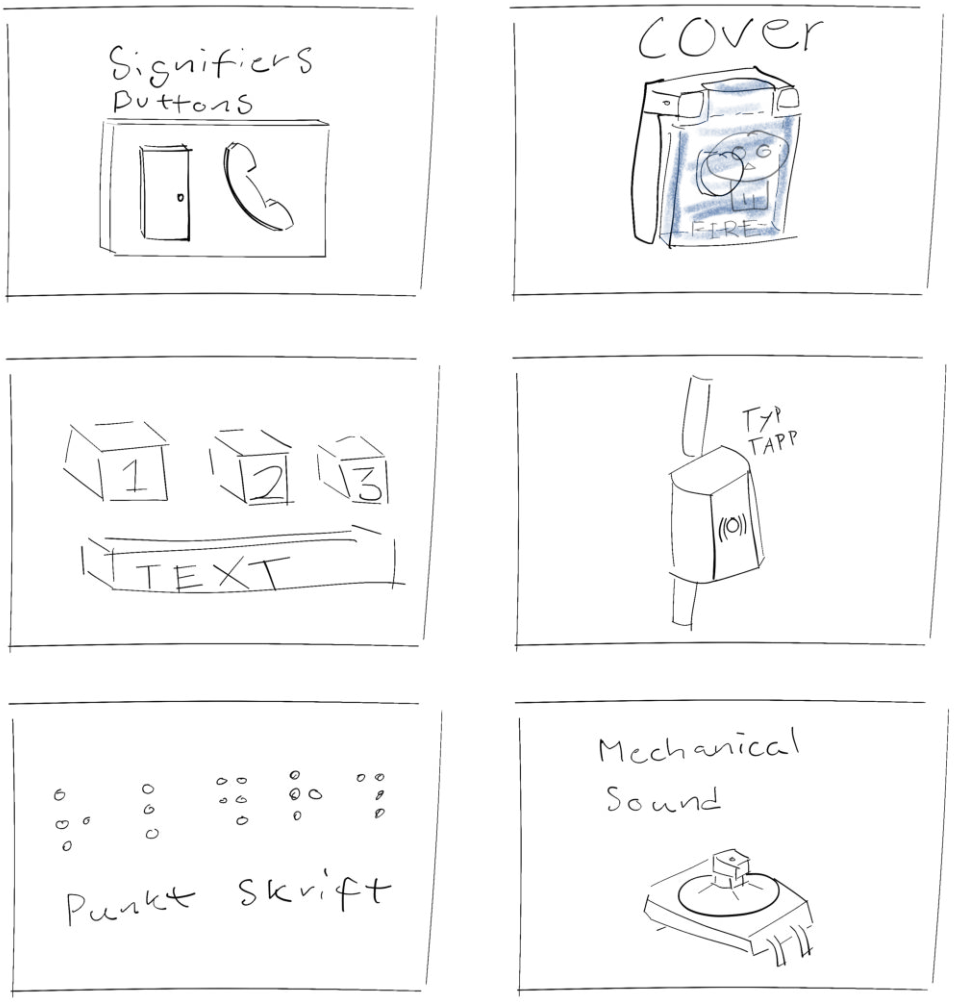

Figure B.5: Lightnings Demos

Appendix C

User testing data of Barbro

Test 1 (Name): Anonymized Scenario: B,C

Testers notes:

Kom in smidigt, ingen feedback ringde, tryckte på luren först. Finns ingen att det är fel feedback

What problems did we notice?

Questions:

How easily was the task performed (1-5)?

Första va väll enkel fem men ni får fyra så nu får jobba. 2:a på ringa då den inte kändes så självklar. Vill kunna lägga på.

What problems were encountered?

What worked well?

If you could change anything with this product, what would you change?

Övrigt:

Inte helt självklart att det är en knapp. Kanske byter färg när det är klart. Man ser endast ändringar. Inget som säger att man ska swipa kortet. Tror att jag bara kan ringa. Ingen sudda risken är att man måste ta en siffra som blir fel. Ge dom chansen att börja om.
Skanna av marknaden
(1 saknar beep)

Test 2 (Name): Anonymized Scenario: A,D

Testers notes:

What problems did we notice?

Trycker för hårt funkar inte
Kod åt fel håll
Tryckte inte på telefonen

Questions:

How easily was the task performed (1-5)?

A-5 D-3

What problems were encountered?

Klicka på telefon eller siffror först?
Trycka på telefon 2 gånger?

What worked well?

Känns liknande andra produkter.

If you could change anything with this product, what would you change?

Telefonbok t ex

Figure C.1

Test 3 (Name): Anonymized Scenario: A , C

Testers notes:

What problems did we notice?

Questions:

How easily was the task performed (1-5)?

5 blipp funkade. Inte logiskt att telefonen skulle vara blipp funktionen. 2 på telefonen

What problems were encountered?

Klickade för kod när man ville ringa. Ingen feedback på att telefonen ringde

What worked well?

Blipp funkade bra.

If you could change anything with this product, what would you change?

Rött betyder de att dörren öppnas. Lite långsam, inte kul när inget händer.

Test 4 (Name): Anonymized Scenario: B,C

Testers notes:

What problems did we notice?

Questions:

How easily was the task performed (1-5)?

(5)B var enkelt senaio. (3)C luren var lite oklar

What problems were encountered?

What worked well?

Kortet funka bra

If you could change anything with this product, what would you change?

Tydligare telefon. Kanske inte telefon alls

Funka fantastiskt.

Klickade in till code mode när han skulle ringa. Funkde snabbt

Test 5 (Name): Anonymized Scenario: A,C

Testers notes:

What problems did we notice?

Tyckte det var konstigt att han behövde trycka på telefonen 2 gånger

Questions:

How easily was the task performed (1-5)?

A: 5

C: 3

What problems were encountered?

Slår man in fel nummer är man körd, behövs ett sätt att ångra samt en indikation på sifferlängden man knappat in.

What worked well?

Funkade lätt att använda touchpaden

If you could change anything with this product, what would you change?

Kunna ångra och kunna se vad man slagit in.

Figure C.2

Test 6 (Name): Anonymized Scenario: C,B

Testers note:

Testet skedde i sängen med släckt rum detta medförde att det var relativt hög kontrast på de släckta knapparna.

"Övrig tanke-Varför har vi + & # (ingen använder dom)"

Questions:

How easily was the task performed (1-5)?

B - 4

C - 3

What problems were encountered?

Visste inte om man skulle klicka på siffrorna först eller luren när hon försökte ringa. Koden skrevs fel många gånger saknades feedback på vissa klick. Förstod inte vad dörren betyder, ska man trycka på den? Tänkte att man kunde trycka på luren som också hade blippen bilden.

What worked well?

Blev glad när den lyste grönt, Vilket tolkas som att man lyckats.

If you could change anything with this product, what would you change?

Nämnt tidigare men vet inget konkret.

Test 7 (Name): Anonymized Scenario: A,D

Testers notes:

What problems did we notice?

Användaren klarade scenario utan problem men behövde få information om att lappen med koden var på fel håll.

Questions:

How easily was the task performed (1-5)?

A: 5

D: 3

What problems were encountered?

Ser inte vad man tryckt, att trycka på telefonknappen två gånger kändes konstigt

What worked well?

If you could change anything with this product, what would you change?

Gillar att kunna komma in med enbart kod

Test 8 (Name): Anonymized Scenario: D, B

Questions:

How easily was the task performed (1-5)?

D - 3 Minns ej om vi fråga B - 4 Minns ej

What problems were encountered?

We did start the old Beer prototype by mistake. So the where lots of bugs. Fome feedback was missing.

What worked well?

The idé of using a touchpad is good because it's easier to get rugged compared with a touch screen.

If you could change anything with this product, what would you change?

That we could add the near sensors. Because then there can be another standby mode. By approaching the product it would "wake up".

It is needed that Is activated ljud slingan.

Figure C.3

Appendix D

User testing data of Jake Safety

Test 1 (Name): Anonymized
Scenario: B
Stress innan: 1
Puls innan: 72
Stress efter: 1
Puls Efter: 74
60-70db.
Kommentarer:
Vi känner hen väl vilket troligtvis gör hen tryggare i situationen.
Observationer: Hen stångade knappen med huvudet vilket gjorde att piso knappen registrerade två klick. Detta gjorde att samtalet till "Sos" fick det som missat samtal.

Test 2 (Name): Anonymized
Scenario: B
Puls innan: 77
Stress 1-10: 4
Puls efter: 86
Stress 1-10: 7
70-80dB
Kommentarer:
Låg ljudnivå från Jakke Safety
Observationer:
Where needing to have his face close to Jakke Safety to be able to hear.

Test 3(Name): Anonymized
Puls innan: 87
Stress 1-10: 3
Puls efter: 81
Stress 1-10: 5
Kommentarer:
Visste inte om den ringde eller inte. Tryckte två gånger vilket gjorde att hen råkade lägga på. Sitter långt ner.
Observationer:
Lågt ljud.

Figure D.1

Test 4(Name): Anonymized
Puls innan: 84
Stress 1-10: 2,5
Puls efter: 81
Stress 1-10: 7
Kommentarer:
Långt ner
Hen kände att skadan var för mild för att hen skulle våga använda en nödtelefon.
Dålig ljudnivå
Observationer:
Vill veta om hen ska lägga på?
Vill veta vem man ringer
Lite mer info
Test 5(Name): Anonymized
Puls innan: 95
Stress 1-10: 6
Puls efter: 100
Stress 1-10: 8
Kommentarer:
Lite svårt att höra
Observationer:
Test 6(Name): Anonymized
Puls innan: 81
Stress 1-10: 2
Puls efter: 84
Stress 1-10: 4
Kommentarer:
Dåligt ljud
Behövde trycka på knappen flera gånger innan det fungerade
Observationer:
Instruktioner kanske behövs.
Test 7(Name): Anonymized
Puls innan: 80
Stress 1-10: 5
Puls efter: 84
Stress 1-10: 6
Kommentarer:
Dubbelklick
Observationer:
Dålig respons på när det är tryckt
Dålig ringsignal

Figure D.2

Appendix E

User testing data of Berit

Test 1 (Name): Anonymized
Scenario: A,C
Testers notes:
What problems did we notice?
Maybe a hello button
Questions:
How easily was the task performed (1-5)?
A-2
C-5
Test 2 (Name): Anonymized
Scenario: B,D
Testers notes:
What problems did we notice?
Behövde tänka om de va något med 5an och 8an.
Questions:
How easily was the task performed (1-5)?
B-4
D-3
Test 3 (Name): Anonymized
Scenario: C,D
Testers notes:
What problems did we notice?
Koden innan kortet.
Questions:
How easily was the task performed (1-5)?
5-D
3-C
Test 4 (Name): Anonymized
Scenario: B,C
Testers notes:
What problems did we notice?
Questions:
How easily was the task performed (1-5)?
B-5
C-2

Figure E.1

Test 5 (Name): Anonymized
Scenario: C,A
Testers notes:
What problems did we notice?
Såg inte den gröna leden
Questions:
How easily was the task performed (1-5)?
A-4,5
C-5

Test 6 (Name): Anonymized
Scenario: B,C
Testers notes:
What problems did we notice?
försökte skriva kod innan blip
Questions:
How easily was the task performed (1-5)?
B-5 C-4

Test 7 (Name): Anonymized
Scenario: B,C
Testers notes: inga problem
What problems did we notice?
Questions:
How easily was the task performed (1-5)?
B-5 C-5

Test 8 (Name): Anonymized
Scenario: B,C
Testers notes: inga problem
What problems did we notice?
Questions:
How easily was the task performed (1-5)?
B-5 C-5

Test 9 (Name): Anonymized
Scenario: B,C
Testers notes:
What problems did we notice?
försökte skriva kod innan blip
Questions:
How easily was the task performed (1-5)?
B-5 C-5

Figure E.2

Appendix F

Benchmark

Länk: https://www.toa-products.com/international/download/spec/n-8000ex_ce_cb1e.pdf

Description: Door Intercom Series from AIPhone

AIPhone has countless of different intercom products in their portfolio.

Link:
https://www.aiphone.com/home/products/ix-series

Figure F.1

Emergency Phone:

Description: Emergency Phone from KNTECH

Video intercom, use high-definition camera, metal casing, suitable for subway, airport and other public places for emergency help intercom.The video intercom adopts the ip protocol to access any sip server, the call quality is good, and the video image is clear.

Link:
https://www.koontech.com/Video-intercom__40.html

Exists in many different configurations, for example:


Model: KNZD-70

Passenger Assistance Intercom


Model: KNZD-70E

Sip intercom

Model: KNZD-60-2IPIL

Ip intercom


Model: KNZD-60

Voip intercom


Model: KNZD-60M

Video help point

Model: KNZD-20

Video intercom


Model: KNZD-20W

School intercom


Model: KNZD-11

SOS Intercom

For more configurations, see:
https://www.koontech.com/Emergency-telephones.html?gclid=Cj0KCQiAtqL-BRC0ARIsAF4K3WFRsir3ud-kaHuAjqtNegTmdXN8imi0ZlauIGZhAIA9PxeFnxaVblAaAjo5EALw_wcB

Figure F.2

Door Intercoms:

Description: Door Intercom from Kntech

Video RFID doorphone, RFID is an easy to operate, simple and practical and is especially suitable for the flexibility of application technology for automation control, identify work without manual intervention, it can support the read-only mode can also support reading and writing work mode.

Länk:
https://www.koontech.com/Video-RFID-doorphone__380.html

Exists in many different configurations, for example:

Model: KNZD-52V

Video RFID doorphone

Model: KNZD-51

Access Control

Model: KNZD-47A

Sip stations

Model: KNZD-45A

Outdoor intercom

For more configurations, see: https://www.koontech.com/Access.html

Description: Door Intercom from Toa-products

Toa-products develop and sell complete IP integrated systems similar to Axis. With door stations, cameras, speakers and control units. They appear, however, to be of less quality as the only IK-rated product found had an IK02 rating.

Figure F.3

Appendix G

Coloring samples

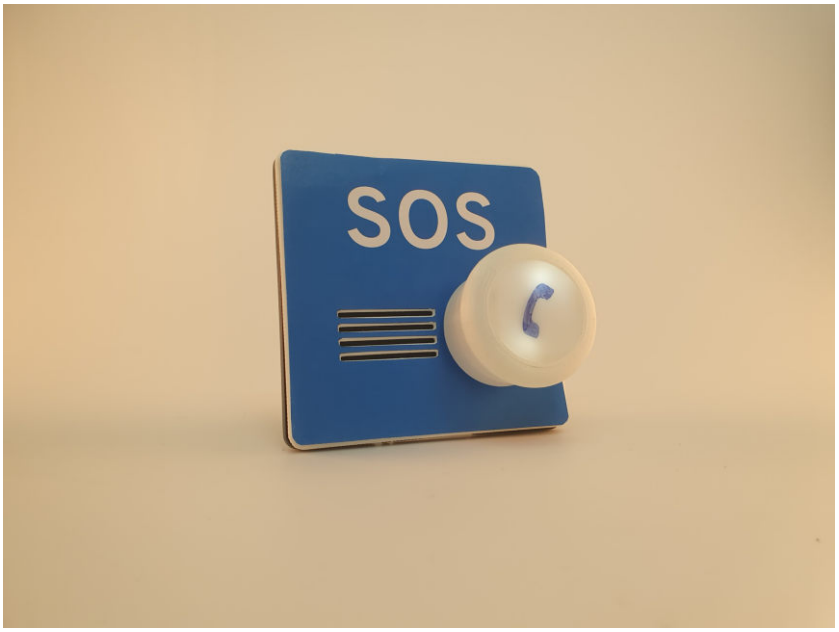

Figure G.1

Figure G.2

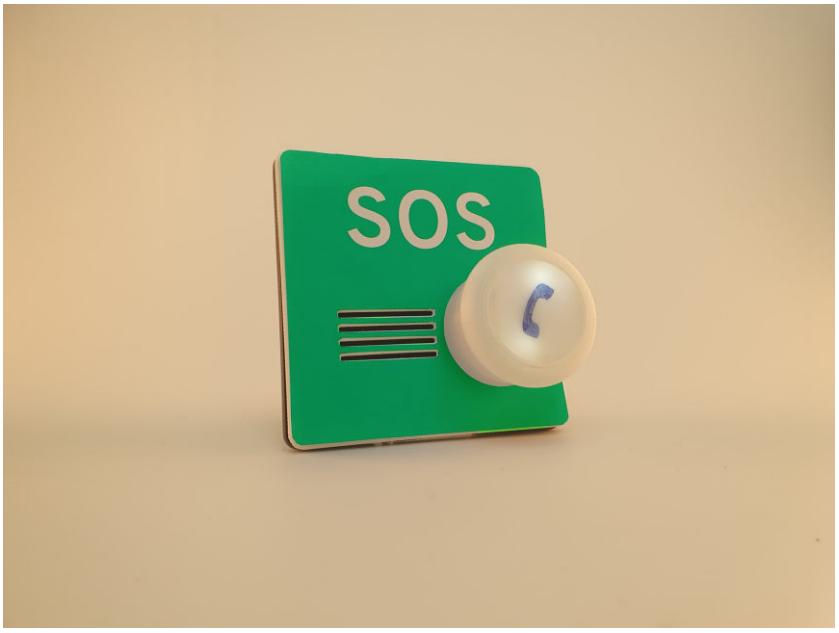

Figure G.3

Thank you!