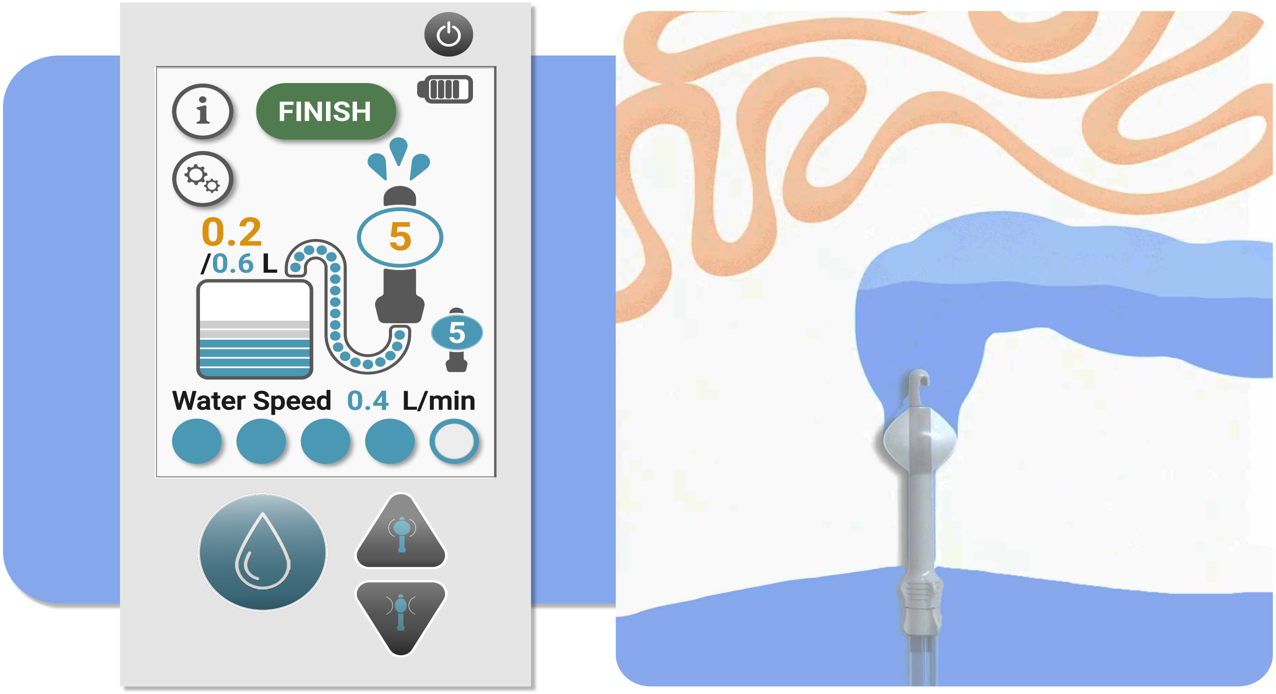
CHALMERS
UNIVERSITY OF TECHNOLOGY



User Experience Prototype for Simple and Intuitive Transanal Irrigation

Master's thesis in Industrial Design Engineering

FREDRIK KARLSSON

DEPARTMENT OF INDUSTRIAL AND MATERIALS SCIENCE
DIVISION OF DESIGN AND HUMAN FACTORS

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021
www.chalmers.se

Master of Science Thesis, IMSX30

User Experience Prototype for Simple and Intuitive Transanal Irrigation

Fredrik Karlsson

Supervisor: Lars-Ola Bligård
Examinor: Lars-Ola Bligård

DEPARTMENT OF INDUSTRIAL AND MATERIALS SCIENCE
DIVISION OF DESIGN AND HUMAN FACTORS

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021
www.chalmers.se

User Experience Prototype for Simple and Intuitive Transanal Irrigation

Master's thesis in Industrial Design Engineering

Chalmers University of Technology
SE-412 96 Gothenburg, Sweden
Tel. +46(0) 31-772 1000

Cover image: Fredrik Karlsson
All images by Fredrik Karlsson unless otherwise stated
Print: Chalmers digitaltryck

ABSTRACT

For most people, the act of going to the bathroom is not a big deal. However, for people with bowel disfunction, this act can be thought of differently. Bowel disfunction can happen to anyone as a result of an illness or an accident. Some people with bowel disfunction use transanal irrigation which is a procedure where the user instill water into the bowel to loosen the feces and to stimulate bowel movement. Using transanal irrigation allows the user to choose when and where to empty the bowel. This enables the user to regain control over a part of their life. The current smart transanal irrigation product which is being redesigned in the thesis have some usability issues and the review functionality is not widely adopted which would be beneficial to solve.

The aim of the thesis is to create prototypes which provides a more intuitive and positive user experience when performing transanal irrigation. Firstly, the project started with three para-llel phases to create understandings: interviews, digital prototype tests and physical prototype tests. Secondly, the insights from the first three phases have been used to create requirements, focus areas and guidelines to influence the concept decision and the next designs. Lastly, a final prototype was designed to be used for further testing.

The final prototype uses a combination of physical buttons which ensures that the user feels in control when performing the treatment and a resistive touchscreen which enables an easy way to interact with interface. The experience of reviewing the treatment has been simplified and put in the device, from previously being in an app. This enables the user to faster and more conveniently make the review. The interface also includes information boxes and more informative error messages which lets new users learn about the treatment.

This project is thought of as one iteration of the development and thus multiple more needs to be made to cover more areas. The result of this thesis helps the development of the unit to take a step in the right direction in terms of further considering the needs of the users.

Keywords: Interaction design, Prototyping, Human-centered design, MedTech, eHealth, User testing, User Interface

AKNOWLEDGEMENTS

I would like to begin this thesis by expressing my gratitude to the ones who have helped me through this project.

Firstly, I would like to thank Wellspect Healthcare and Kjell Wellenstam who have given me the opportunity to work with this exciting project. I would like to give Malin Kruse a special thanks as she has been supervising and supporting me throughout the thesis as a representative from Wellsepect Healthcare. Gabriel Espindula and Anders Johansson who have helped me with technological aspect and helped in build the physical prototypes are two people who I also wish to express gratitude towards.

A big thank you to all the people who I have had the opportunity to interview and all the people who was a part of testing the digital and the physical prototypes in the user tests. Without giving of your time this thesis would not be possible.

I would also like to thank those who have read the thesis to improve on its language and pedagogical presentation.

Finally, I would like to thank Lars-Ola Bligård at the Division of Design and Human Factors at Chalmers University of Technology who have supported me throughout the thesis. Your academic guidance has been invaluable.

Thank you all!

Fredrik Karlsson

TERMINOLOGY

UI - User Interface

UX - User Experience

HMI – Human- Machine Interface

HCD – Human- Centered Design

TAI - Transanal Irrigation

GDPR - General Data Protection Regulation

CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

1.

INTRODUCTION

This thesis covers the process of developing prototypes for testing, testing the prototypes and iterating based on the results. The setting is in the medical technology field and is made together with Wellspect Healthcare with their project group who work on smart transanal irrigation (TAI).

1.1 Background

Most people do not have to spend much time thinking about going to the bathroom but for people with bowel disfunction this takes up more thought. Bowel disfunction can happen to anyone as a result of illnesses or accidents. Symptoms related to bowel disfunction can be caused by spinal cord injury, rectal or colon cancer and Parkinson's disease. Some illnesses and functional variations which cause bowel disfunction also have other symptoms which affect the user. The users of the current product often have lowered hand dexterity as the product do not require the user to pump the air and the water manually. A substantial part of the users of the current product is also in a wheelchair.

What the current product does is to perform transanal irrigation. This kind of treatment can be prescribed by healthcare professionals if dietary plans and medication does not work. Performing transanal irrigation means to instill water into the bowel to initiate bowel movements. When the water catheter is removed the bowel can be emptied. To ensure that the water can be instilled into the bowel without leaking a balloon is inflated in the bowel and then deflated when the catheter is being removed. This process is carried out on the toilet.

Using transanal irrigation allows the user to choose when and where to empty the bowel. After the treatment the user have an empty bowel and should not be worried to leak. This makes the user gain control and independence over their bowel and avoid a bowel accident.

There are different ways of dealing with bowel disfunction where the current product named Navina Smart is one of them. Using a product for helping with bowel disfunction can be frustrating if it does not work smoothly without confusion. Wellspect and this thesis view of the issue is therefore that people with bowel disfunction should not have to think about going to the bathroom more than others, and they should be able to perform transanal irrigation smoothly to then go about their day.

There are multiple stakeholders which are related to the product. The most important stakeholder is the user as it is they who use the product. Other relevant stakeholders are the healthcare professionals who help the users to understand the product and who help them to improve their use with the product. There are also sales representatives from Wellspect who are involved with informing users and healthcare professionals about using the Navina Smart unit. Other important stakeholders are the research and development team as well as the people working with quality as they are the ones who develops the product and ensures the safety of the product.

Today's product is presented with some challenges which can make it difficult to use, in particular for new users. This is a product can cause stress as it includes inserting a catheter rectally, inflating a balloon and instilling water. Therefore, outside factors such as not being comfortable with the interface of the product should not be an issue. The thesis will therefore focus on the interface challenges that makes it difficult to use the product as the users already have enough to think about when starting to use this kind of product. Making it more effortless, with less issues will therefore help the users to improve their life situation.

1.2 Aim and Objectives

The aim of the project is to create a concept that provides a more intuitive and positive user experience when performing transanal irrigation (TAI) for adult users. The project focuses on the interface of the control unit which in this case is the screen and the buttons to interact with it.

The objectives of the thesis which will help to answer the research questions and create deliverables for Wellspect are:

- Create understanding for the kinds of problems that might occur, and the users experience in the interaction between the users and the product when performing TAI and to present the information to be used in this thesis and for further use by Wellspect.

- Create digital and physical prototypes focusing on user interaction and user experience which will be used to create knowledge about usage and to be used in the future for further testing.

- Combine the input from user insights and prototype testing to create requirements to influence the prototypes to be used for the following iteration and to be used by Wellspect in the future.

- Create a final physical prototype representation view, based on the knowledge gained in the project, from the front and a digital interface prototype to represent the next version of the Navina Smart system.

1.3 Research Questions

As the aim of the thesis is to create a concept that improves the interaction between the user and product and that creates a more positive experience for the user, the research questions focus on understanding aspects on how that can be made possible.

- What are the factors that make the use of the product intuitive and what is considered a positive experience in relation to the use of the product? Also, which kind of positive experience does the product want to accomplish?

- How can the design of the interface and the buttons of the product give the user a sense of control even if some aspects of the interaction are automated?

- How can the interaction with the product be both informative enough to guide a beginner while still be efficient to use for an experienced user?

- How do the suggested improvements affect the users, the salespersons, the nurses and the R&D department?

1.4 Demarcations

The product that the project concern has multiple parts and to make sure the project creates valuable results in the time of the thesis, it will require the focus on the interaction with the interface. The interface is connected to the other parts and knowledge on how the other parts of the product functions is needed but the designs that will be created will focus on the physical control and the digital interface. Therefore, the design of the pumps station and the shape of the control unit will not be taken into consideration.

Navina Smart is sold in multiple countries and thus has users with different cultures, but this thesis will focus on Swedish users. This is to get a better chance at talking to participants in their native language and to easier compare results from the interviews.

1.5 Project Situation

The project is made as a part of a project group at Wellspect which focuses on the Navina Smart unit and where there are people with different skillset such as embedded systems, software development, project management, customer relations and IT. Being a part of a team creates close contacts to other disciplines to bounce ideas and receive help with aspects of the project which is great as this thesis is done individually.

1.6 Thesis Outline

Here, the outline for the thesis is presented by explaining each chapter.

Chapter 1 Introduction, presents the purpose and aim of the thesis. This chapter also puts the thesis in context and says why this is important.

Chapter 2 Context, brings up topics related to the product in order to make it easier for the reader to grasp what the thesis is about. The context brings up topics such as illnesses which can cause the need for this product and how the current Navina Smart unit is used.

Chapter 3 Theoretical Framework, describes the theory which is used in the thesis and how it is used. Examples of theory which is presented is how a design process can be performed in order to have a human-centered design approach and theory related to how to create meaning in an interface.

Chapter 4 Method, introduces the process of the thesis and the methods used. Examples are methods regarding how the interviews are conducted and how the prototypes are being used to test aspects of the product.

Chapter 5 Interviews and Insights, presents the results from the interviews conducted with the users and other stakeholders. The chapter also draws insights from the interviews and presents personas based on the interviews and a representation of how the users interact with the product.

Chapter 6 Digital Prototype Tests, describes how the digital prototypes was developed, how the tests was performed and which insights are drawn from the tests.

Chapter 7 Physical Prototype Tests, describes how the physical prototypes was developed, how the tests were being performed, which data was collected from the tests and what insights were drawn from the tests.

Chapter 8 User Needs and Prototype Decision, starts with presenting requirements and focus areas for the final prototype which is followed by a discussion of which concept to choose. In the last part of the chapter guidelines to how the final prototype should be designed based on theory and insights from interviews and prototype tests are presented.

Chapter 9 Final Prototype, shows how the final prototype looks and describes the flow of the prototype as a whole and each section of the prototype and the design decisions which made it look the way it does.

Chapter 10 Discussion, consists of discussions of different topics related to the thesis such as the final result, challenges in the work and the relevance of this work.

Chapter 11 Conclusions and Further Development, is the final chapter of the thesis and presents the answers to the research questions and other conclusions. Lastly it presents how this work can be further developed.

W

2.

CONTEXT

In this chapter, context to the project setting and descriptions of factors affecting the user and the project is described as well as information about the current product. In addition to this what is causing the user to have to use this product is also described.

2.1 Bowel Disfunction

Having persistent problems with the bowel is challenging and can have implications which affect the quality of life, for instance on social life and easiness of going to work (Wellsepct, n.d.a). While at the same time as it poses a big issue, it is a topic which is difficult for the affected to talk about. Wellspect (n.d.a) express that it is important to discuss the use for the affected as the right treatment has the possibility to give the patient their life back. There are various different kinds of bowel disfunction such as chronic constipation and fecal incontinence, which can cause accidents and a lack of bowel control and this can lead to spending a lot of time in the bathroom.

The causes of bowel symptoms can vary. According to Wellspect (n.d.a), when the reason is caused by a neurogenic issue it is called neurogenic bowel dysfunction and be caused by injuries and diseases which have affected peripheral nerves or the central nervous system where examples are:

- Spina bifida
- Parkinsons disease
- Multiple sclerosis
- Spinal cord injury

Some other conditions which can affect the bowel and lead to bowel dysfunction are:

- Hirschsprung's disease
- Pelvic floor dysfunction, as a aftermath after childbirth
- Rectal or colon cancer
- Anorectal malformation
- Anal surgery
- Functional bowel disorders, where there are no underlying causes which can be found for the symptoms.

Vårdhandboken (2021) writes that, the definition of constipation is summarized to ”have sparse stools and / or problems with the actual emptying of the bowel such as excessive clotting, hard stools, feeling of incomplete bowel emptying, long time to empty the bowel or other difficulties in getting the stool out”. To have issues with constipation and evacuation of the bowel can be troublesome and embarrassing for the affected.

According to Vårdhandboken (2020), anal incontinences' definition is involuntary discharge of gas, lose or solid stools which results in hygienic and social implications. Anal incontinence is a symptom and not an illness and there are usually multiple reasons why this symptom is caused, and therefore an investigation is important. The goal with the investigation is to normalize or improve the bowel to receive a better quality of life and it should therefore be made as early as possible (Vårdhandboken, 2020).

2.2 Transanal Irrigation (TAI)

Transanal irrigation (TAI) can be an option in treatment for people who spend long time on the toilet or who experience bowel leakage.

The steps of TAI treatment provided by Wellspect (n.d.b) are;

1. Inserting the catheter rectally until it reaches the handle of the catheter.

2. Inflate the balloon to ensure that the catheter stays in place and seals the rectum throughout the treatment.

3. Instill water (irrigate) into the bowel. The water will help to loosen feces and stimulate bowel movement. Turn of the water flow and wait.

4. Lastly, deflate the balloon and remove the catheter. Let the bowels empty. The time it takes to evacuate is individual and can vary.

By performing TAI regularly, the bowel can be emptied efficiently. The treatment allows the user to choose the place and time for when to empty the bowel. This gives the control back to the user which in turn makes the user more independent and makes it easier to live the life the person prefers without having to worry about having an accident or a spent too long on the toilet (Wellspect, n.d.c).

According to Wellspect (n.d.c), to succeed with TAI it is important to set a realistic time frame for reaching comfortable usage of TAI, which can be up to 12 weeks. This is because it can be difficult to find the optimal routine for irrigation for the individual. When the user has set in to performing TAI and found a routine that works it can be enough to only irrigate every second day, but it varies.

The option to use TAI is usually chosen when other treatments such as diet restrictions and medication have not helped. It is healthcare professionals who decides if TAI is suitable for the individual or not (Wellspect, n.d.c).

2.3 Navina Smart

The product which this project is based on is Wellspect's Navina Smart unit that performs TAI by using software to control pumps to instill the water and to inflate the balloon. This allows for full control of the treatment. The data from the treatments are possible to be transferred to an app that stores it and can show information regarding previous irrigation. This information can be used to keep track of the treatments and to share with doctors and nurses Wellspect (n.d.d).

Wellspect (n.d.d) express that the goal with the Navina Smart unit is to make the TAI treatment as user friendly as possible and to increase the level of success and compliance for the individuals that are testing the product and thus make TAI treatment more accessible for a wider group of people.

Some benefits from using the Navina Smart unit compared to a non-electrified unit is according to Wellspect (n.d.c);

- The electrified pumps demand less physical power and coordination.
- Touch buttons makes the user have full control over inflating the balloon and the water flow.
- Build in limits such as set maximum levels for water volume and balloon inflation makes it more secure.
- The Navina Smart unit can be used by children from age 3 because of its built-in system that limits the pressure in the bowel.
- The possibility to personalize the treatment settings makes the treatment more accurate.
- Collects the data from the treatment to be able to analyze and improve the experience.

Figure 1: the Navina Smart components: water tank, tubes and control unit (Wellspect, n.d.d).

2.4 Navina Smart Intended Use

This intended use is based on the instruction video provided by Wellspect (n.d.d). The video focuses on teaching new users how to perform the treatment and what steps the treatment should be performed in, every step is not needed for an experienced user as settings has been saved from earlier uses. The steps are according to Wellspect (n.d.d):

1. Enter the personal settings which are agreed by the healthcare provider. The settings include, balloon size, water amount and speed of the water.

2. Fill the water container to the maximum amount. Use, lukewarm water as it is most comfortable to use.

3. Open the catheter package and place the adhesive area in a place which is easy to reach while sitting on the toilet, such as the wall or the inside of the sink.

4. Remove the safety caps from the control unit and connect the blue tubing to the blue connector of the water container and the control unit. Then connect the white connector to the control unit and the catheter.

5. Start the Navina Smart by tapping the on button.

6. While having the catheter in the package, press one of the droplet buttons to expel air and wet the catheter to activate the hydrophilic surface. This fills the water tube with water and makes the surface of the catheter slippery.

7. When the catheter is soaked in its packaging, press the deflation button on the control unit to go to instillation.

8. Insert the catheter whilst sitting on the toilet.

9. Press and hold the inflation button to inflate the balloon. The Navina Smart will not expand further then the predetermined size setting.

10. When the balloon is inflated water can be instilled. When pressing and holding the button, the water will be instilled with a constant flow which is also showed on the units' screen. The one-droplet button can be used for slower speeds and the two-droplet button can be used for higher speed. If the maximum water level is reached the system stops pumping.

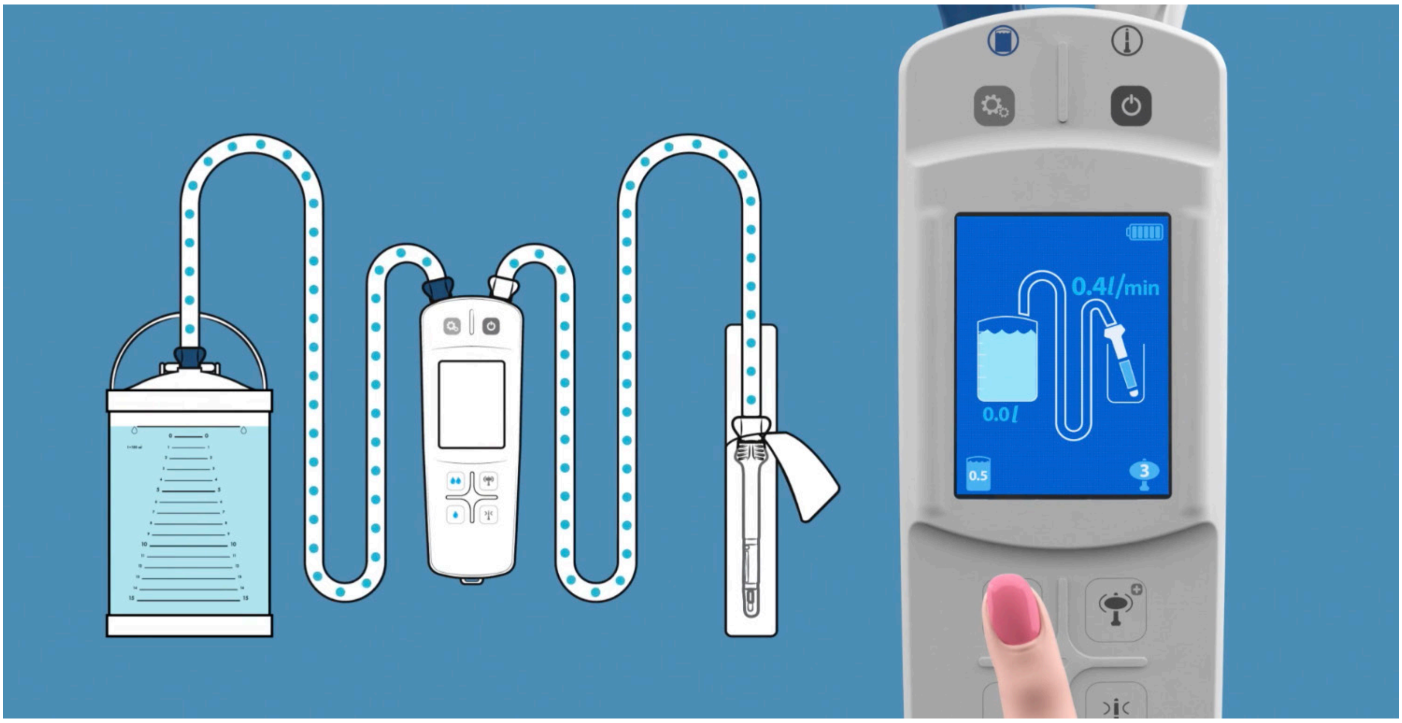


Figure 2: showing how the water goes and how the control unit looks when priming (Wellspect, n.d.d).

11. To deflate the balloon, press and hold unit the catheter on the display shows that it is fully deflated.

12. Remove the catheter and allow the bowel to empty, this can take varying amounts of time and is unique to everyone but takes on average 10-30 minutes. The unit should be kept turned on to record time spent

13. To disassemble the unit, open the lid of the water container to release the pressure. Then remove the tube with the white connector and empty the water from the tube. Proceed to remove the dark blue connector from the control unit, turn off the unit, remove the blue connector from the water container and disconnect the catheter from the tubing.

14. Throw the catheter in household waste.

15. Clean and dry the remaining parts of the Navina Smart. The tubing and the water container can be washed with mild soapy water.

In the video the app is mentioned as a way to track your progress over time. It is also mentioned that catheters are for single use.

2.5 Data Collection

With the Navina Smart it is possible to track pressure in the bowel and have that data in collaboration with the used sizes for the balloon and water amount. This data can give insights to how the bowel works. This data is used in research to be able to improve the lives for people with bowel dysfunction. In the app which can be used in collaboration with the current Navina Smart unit it is possible to rate the experience and thus give more depth to the data set. The issue is that just a small number of users rate their experience in the app, partly because it is an additional task that needs to be done separately which takes time and the user might not understand the benefit. Reviewing the treatment each time is thus not just for the patient's own benefit as it contributes to bowel research as a whole. Trying to make the users more receptive to sharing their experience as it directly affects research and thus can help the patients to improve their quality of life by giving them incentive and minimizing effort therefore became a part of the thesis.

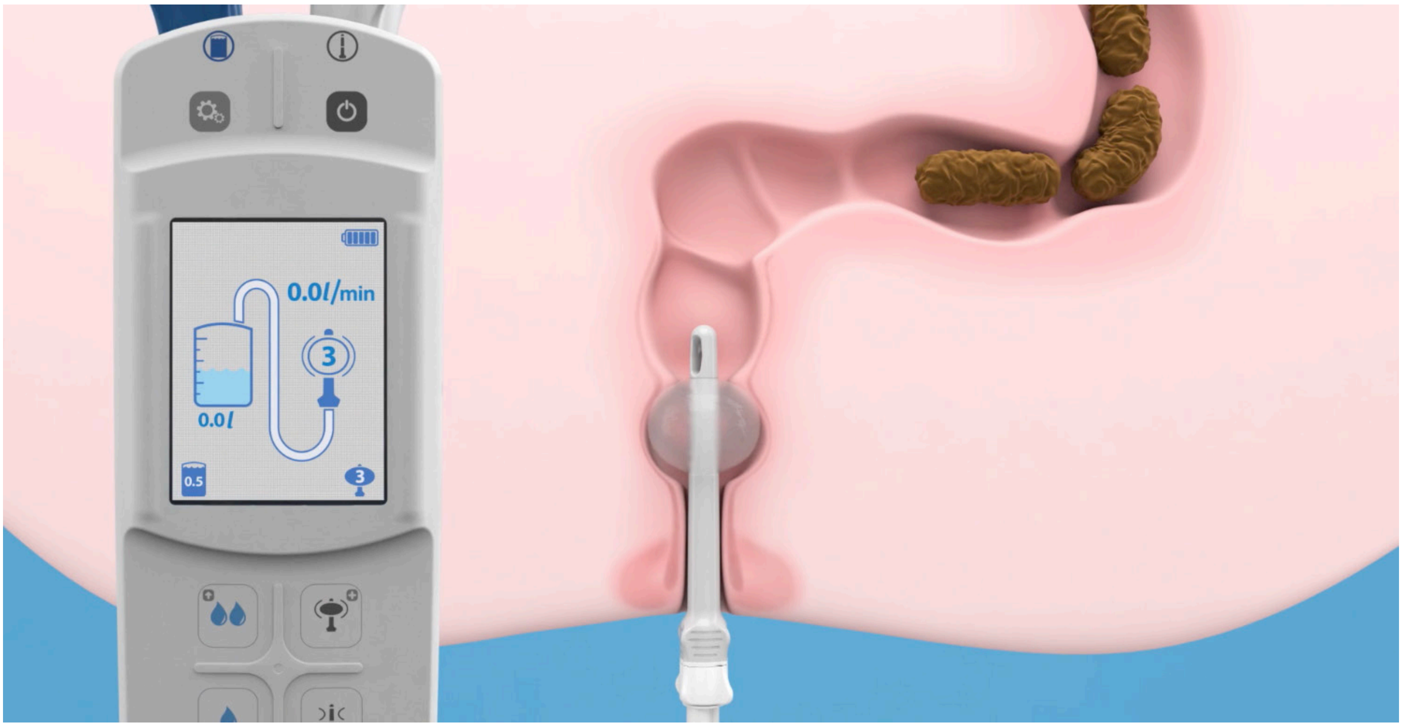


Figure 3: The control unit when treating and the catheter inserted with the balloon inflated (Wellspect, n.d.d).

2.5 Stakeholders

Here, the five main stakeholders that are interested in the Navina Smart system are presented and how the information flows between them.

2.5.1 R&D

The Research and Development (R&D) team is the people who develop and update the product to make sure it works as intended. They are also the decision makers when it comes to what should be changed in the product. The team consists of both a project leader, IT-, software- and hardware professionals. The R&D team get input from a market professional that helps to inform them what the users are experiencing.

2.5.2 Sales Representatives

The sales representatives sell both the Navina Smart and some other products and interacts a lot with healthcare professionals (HCP) but also some with end users. The communication is both when selling the product and when answering complaints. As a stakeholder they are important because if they believe in the product and think it is a good fit for the person, they want to sell it and thus more can be helped by the product. What the sales representatives thinks of the product is therefore also important.

2.5.3 Nurses / HCP

HCPs are Healthcare professionals, and the main ones are the nurses that inform the users and doctors who prescribe the treatment. Some of the nurses are employed by Wellspect and some are not but all of them have gotten education that regards Navina Smart. The nurses have the closest contact with the users and thus needs to have as much information as possible and understand the product as well as possible in order for them to be able to help the users.

2.5.4 Users

The users are the stakeholders that everyone is trying to please. What the users think is what matters. The Navina Smart system aims to give the users a more pleasant TAI experience where they can have control. If the users do not accept the product or find that the alternatives are better, it does not matter what the other stakeholders think. The users are not the ones paying for the product as the product is funded by the region where the user lives.

2.5.5 Assistants

The assistants are the users' personal help which only have contact with the user and gain information from them regarding the product. The user might not always have the same assistant and thus the new assistants need to be introduced to the product by the user who is receiving the treatment.

2.5.6 Information flow

The main way that information travels between the stakeholders are that R&D talks to the sales representative that talk to the nurses who then interact with the users as seen in figure 4. There are occasions where stakeholders jump over another stakeholder and talks to the next. There is also a dimension of information flow which is that the users upload their data to the cloud which HCPs and R&D then takes part of to improve the situation for the user. A problem that is expressed from R&D is that they feel like they do not receive enough information and thus they do not know what needs to be changed.

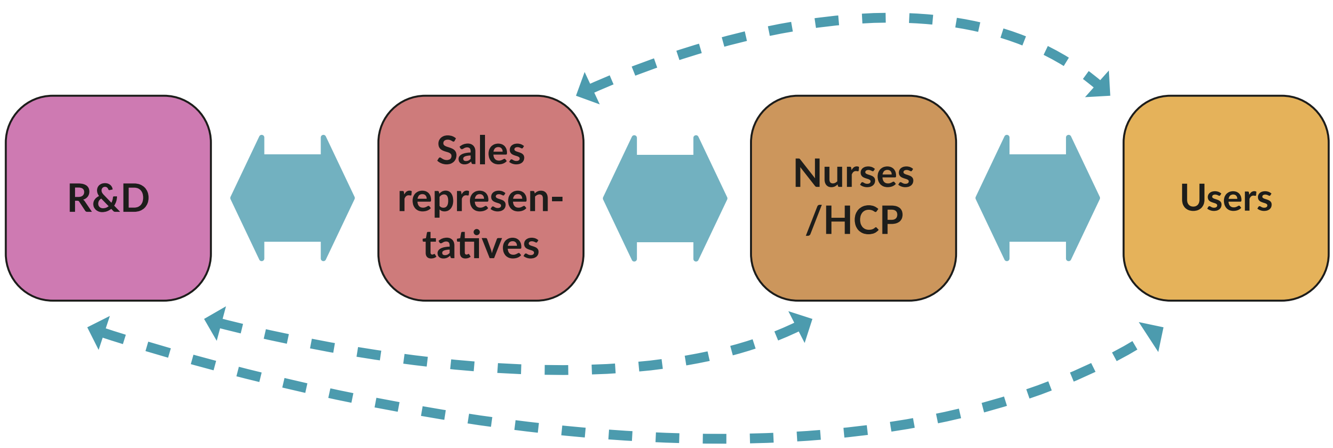


Figure 4: how information travels between the four main stakeholders.

2.6 Context Summary

The project is placed in the context of performing TAI treatment using a digital interface. The need to perform TAI is due to bowel disfunction which can be a result of illnesses or accidents and can happen to anyone. The Navina Smart unit used today is designed to be used by users with lesser hand dexterity which needs to be taken into consideration. Performing TAI using the Navina Smart has a number of set steps which needs to be performed and cannot be disregarded as they are necessary for the treatment.

The context of the thesis also includes a number of stakeholders which interact with each other and have different needs in relation to the product. While everyone wants the user to have a pleasant and efficient experience with minimal issues some stakeholders also want to be able to collect data for research and future development.

3. THEORETICAL FRAMEWORK

The theory presented in this chapter forms the foundation for making decisions regarding the design and how to perform the project to reach the intended goal. The sub chapters bring up topics which has formed the project by presenting the theory and why that theory is relevant to the project. First topics regarding how humans think about design will be presented, then how to design to affect the user correctly will be presented and lastly theory about how to perform a design project and how to think when designing will be brought up.

3.1 The Human in Relation to Design

This section of theory brings up topics related to how the human is perceiving and is affected by design. The subchapter starts with an explanation of a Human- Machine Interface and continues to explain how humans process information, how pleasure in using a product can be achieved and how experience with a product plays a role in the interaction with the product.

3.1.1 Human- Machine Interface (HMI)

Osvalder and Ulfvengren (2015) describes a Human- machine interface as a system where the machine and the human work in symbiosis. Norman (1990) describes a Human- machine interface as a feedback link between the user and the artifact which is necessary for most interactions. He continues and says that interaction with the computer is a cycle where the user gets feedback, evaluates it, executes an action and then receives feedback again.

The Navina Smart has a Human- machine interface and by understanding what the concept of a human- machine interface is, it is easier to see the issues and possibilities which faces this kind of technology. Understanding that there is a loop containing feedback, evaluation and execution and then putting that in relation to the product can give insights on what information should be evaluated, how it easier can be interpreted and how to best act on it to receive the user's goal.

3.1.2 Mental Models

Mental models are, according to Jones, Lynam and Leitch (2011), internal representations made by the individual of the reality of a context/artifact. They continue to say that the model is constructed by the individuals' unique understandings and experiences of the context/artifact. The mental model of users can be used to create decisions based on the individuals' behaviors, and they also say something about what the stakeholder believes to be important and how their interaction with the context/object is being organized (Jones et al., 2011). For this thesis it is used to come closer to what the users will think about the interface. The theory also indicates that to design for a user, a designer must understand what the user thinks about the product, how s/he acts with the product and how interactions with the product shapes the user's way of thinking about the product in the future. Enabling creation of a clearer mental model in the interface is therefore an opportunity that can form the user's interaction and easiness of understanding in relation to the product.

When a person is using an object s/he is creating a mental model of what it is to use that object, but it can also create mental models of doing things that the user has never done before (Weinschenk, 2011). The mental model that is created is then changed and adjusted over time based on your reflection of the experiences you have had. The mental model can also be created and changed by experiencing similar things or hearing something from somebody else. Weinschen (2011) also says that everybody does not have the same mental model for things and by doing user research more understanding about how the mental model looks like can be understood. Lidwell et al. (2010) also express the need for research in order to understand the user's mental model and exemplifies ways of doing research by suggesting that the designer tries out the interaction themselves, usability testing and observations of the user using the system. Liwdell et al. (2010) also suggests using standard mental models for the type of product that is being designed to be more in line with the users existing mental model of the system. This could suggest that changing to much in the interface for the Navina Smart will cause confusion for the current users if they receive a new version as they already have established a mental model of how the product works.

Preece et al. (2002) suggest ”designing technologies to be more transparent” as a way for the user to easier understand the technology. Ways of doing this according to Preece et al. (2002) are;

- Design the instructions to be easy to follow.
- Create access to help, tutorials and guidance for the user to able to get more information.
- Have background information that can let the user understand the functionalities of the technology and why it works as it does.
- Have affordances that lets the interface express what actions are possible and what they mean based on the design.

This type of thinking seems to be useful when designing a product which is used to perform a task, and where the focus is on the task and not the product. This is the case for the Navina Smart and thus the transparent way of thinking when designing is a good way to enable the user to create their mental model of how to use the product to then perform the task.

Preece et al. (2002) express that the concept of transparency is a way of giving the user enough knowledge for them to focus on the task and that the ideal scenario is that the interface disappears and the task is what is given the full attention.

3.1.3 The Skill, Rule, Knowledge-model

This model of thinking about the human behavior is divided into three levels: skill-, rule-, and knowledge-based behavior. The categories are distinguished by representing the constraints in different ways in relation to the human behavior in a deterministic system or environment Rasmussen (1983). Also, to be noted is that the three levels of behavior are not single alternatives, instead they interact with each other.

Skill-based behavior is when the person is skilled enough in performing the task that it goes smoothly without having to be mentally strained. The skill-based behavior comes from doing the tasks many times and they are mostly physical and, in an environment, where the actions do not need to be monitored constantly. Skill-based behavior comes from updating the sensorimotor schemata to be held at the temporal and spatial features in the environment of the task. In the skill-based behavior the way the operator is updating their skills is when the task is done with an error or near an error that is identified. Errors can therefore keep the skill at the proper level (Rasmussen & Vicente, 1989)

Rule-based behavior comes from rules that are either though through formal training or by building them up by experiencing the task many times. By experiencing the tasks many times rules-of thumb can be built from recognizing recurrent conditions and then understand what to do in that situation. The level of consciousness that the task-performer is in-between fully conscious and automatic. The behavior is based partly on principles that functions as shortcuts in order for the operator to not think about each operation that is made (Rasmussen & Vicente, 1989).

Knowledge-based behavior is when the operator of the task is almost completely conscious. This kind of behavior is especially common while performing a new task. Performing a task with knowledge-based behavior requires a lot of mental effort and the task is usually done slowly. After thinking about each task, the user must also evaluate the result of the actions that are made which will further make the task slower (Rasmussen & Vicente, 1989).

Rasmussen and Vicente (1989) explains that it is important to understand that the behaviors at the higher levels are not becoming automated skills. Patterns are formed at the skill-based level to be able to perform the tasks more efficiently while being supervised and controlled by the higher levels. For some actions the rule- and knowledge-based behaviors will be degenerated, and the skill-based behavior will take over control.

Errors can be made in all three behaviors. Hobbs and Williamson (2002) say that behavior that are more conscious are generally more prone to making errors than skill-based behavior. But they have also found that skill-based errors have significant number of incidents. This is said to probably be that the opportunities for errors that are presented and not that skill-based behavior is unreliable. Hobbs and Williamson (2002) conclude that when the error frequencies are normalized against error opportunities, the skill-based behavior is considered the most reliable of the three.

Users of the Navina Smart range from new users to experienced users having used the product daily for four to five years and thus there are multiple skill levels to keep in mind. Designing the interface for the Navina Smart should therefore both be informative enough for the knowledge-based users and allow the user to learn the interface correctly and to an adequate extent such that s/he can perform the treatment with less mental load. Keeping in mind the SRK-model will also enable reflecting about the different levels of expertise and the errors that might occur to them.

3.1.4 Memory

Weinschenk (2011) writes that information is easier to recognize than to recall. When recognizing the user makes use of the context and can thus remember the information by identifying things s/he remembers. Weinschenk (2011) continues and says that when designing an interface the designer should try to eliminate things that requires the user to recall information and instead when possible make use of design cues to make the user remember what to do in a scenario.

Understanding this information about memory says that aspects in the interface which needs to be remembered at times should therefore be able to be recognized to be remembered instead of relying on that the user can remember it by recalling it. Knowing that there is information that the user feels that s/he is lacking, there should be ways for the user to be able to remember it in an efficient way.

3.1.5 Emotions and Pleasure

Hekkert (2006) propose that aesthetic pleasure can be grouped into four principles, and by correctly applying them the result will most likely be an agreed upon aesthetic for the target group. Using these principles in the project can guide the designing of solutions to evoke pleasure in using the product. These principles are:

The first principle, ”maximum effect for minimum means”, is saying that people will prefer a product that requires less effort from the user than a product that requires more with the same effect and that the user enjoys product that can convey a lot of information with a simple design (Hekkert, 2006).

The second principle, ”unity in variety”, suggests that pleasure can come from maximizing the level of order while maintaining as much complexity as possible, performing tasks require the user to see order in the complex and unity in variety (Hekkert, 2006).

The third principle, ”most advanced, yet acceptable”, says that creating balance between novelty and recognizability generates pleasure as people enjoy new things as well as repeating what they already know (Hekkert, 2006).

The forth principle, ”optimal match”, revolves around matching sensory input to each other and that a congruent whole of the sensory inputs, different inputs from the product match each other in the context, from a product creates pleasure (Hekkert, 2006).

The aspect of esthetically pleasing products also needs to be taken into consideration, as Norman (2002), puts it ”attractive things work better” and this is partly due to that the user feel more calm and happy when using the product which helps with performance. Putting effort into making something that appears to be esthetically pleasing therefore pays off.

Norman (2004) writes that for a simplified and more useful way of looking at emotions in design, pleasure can be describes in three levels:

- Visceral design - The appearance of the artifact. This level is subconscious and is induced when the product has been scanned by our senses.
- Behavioral design - The pleasure coming from effective of use. This is related to the usability of the product and how well the user perceives the product to function.
- Reflective design - How self-image, personal satisfaction and memories makes us think about the artifact.

Norman (2004) says that there can be trade-offs made between the levels to make one better of the cost of another and these trade-offs can be smart to make as some products benefit more from certain type of design and the pleasure coming from it. Thinking about the three levels of design while designing and making changes will generate more control over what the user is feeling when using the product and by understanding what the user values in the particular product you can match the design with the needs and thus give the user more pleasure and develop more liking for the product.

3.2 The Interface in Relation to the Human

In this subchapter topics related to how to design a product to be easy to be interpreted for the user are brought up. The chapter brings up how the designer can think regarding product complexity, text in the interface, shapes in the interface and interface colors in order to affect the user in a correct the desired way. The chapter also describes gestalt principles and interaction design principles which can be used to make the design understandable.

3.2.1 Product Complexity

Complexity can be used as a tool by the designer to affect how the user is perceiving the artifact. Stolterman (2008) says that simpler systems are easier for users to comprehend. He continues with saying that lack of complexity also could pose a problem as the lack complexity can lead to lowered motivation and stimuli. High complexity can bring engagement and entertainment to the user (Stolterman, 2008). Complexity should therefore be thought of as something that needs to be balanced and doing to in the particular context with the potential user in mind.

Norman (2016) also talked about the benefits of complexity as complexity creates richness to our lives, but only if the complexity is meaningful, makes sense and is understandable. He continues to say that more features do not give a greater capacity and a simpler interface do not necessary give better usability, this is dependent on what the user is trying to do and when s/he wants to know.
To create a rich experience the designer has to create a design to translate the complexity to something the user understands for him/her to be able to do what s/he wants to do.

Another approach to simplicity is that of the famous designer Dieter Rams who said that “For design to be understood by everyone it should be as simple as possible” (Hustwit, 2018). This could be considered less nuanced but, in this case,, Rams only focuses on understandability and not richness of experience. Dieter Rams also said ”Less but better”(Rams, 2014). This saying can insinuate that dealing with complexity can be done by emphasizing the quality of each element put into the design instead of adding more.

”Less, but better”

Looking at the interface with level of complexity in mind creates new ways of experiencing the interface. By having in mind that complexity can be balanced to match the intended purpose and to match the expectations and needs of the different users gives another tool to be used in designing the experience of using the product.

3.2.2 Interface Text

Font size matters a lot, and the text need to be big enough for users for the interface to read the text without feeling strained, writes Weinschenk (2011). She continues to say that this is not just the case for older people but that there come complaints from younger individuals too. Reading on a screen is also harder than to read on a paper, because of the emitting light from the display and that black text on white background it the easiest to read. (Weinschenk, 2011)

The Office of Disease Prevention and Health Promotion (2016) recommend a font size of at least 12-16pt but of the user group is older they recommend font sizes of at least 14-19pt and as serif fonts can be more difficult to read for users with reading disorders, they recommend sans serif fonts. Po-Chan (2019) studied middle aged (45-64yrs) and older adults (65+ yrs.) and found that both groups ideal font size is 22pt.

The size of the font is not the only thing that matters as Lidwell, Holden and Butler (2010) points out. They say that for the text to be legible it should also have a high contrast against its background, and they also recommend using sans serif typefaces as much as possible. The way in which text styles and weights are used can also affect how the user directs their attention.

3.2.3 Interface Color

Color can carry meaning and attributes and thus the attributes can be used in shaping the user’s experience. Colors can be used to group elements, attract attention, induces meaning and enhance aesthetics in design but if applied improperly the colors in the design can harm the function and form of the design (Lidwell et al., 2010). Colors should be used conservatively (about five colors depending on the complexity of the design) and colors should not be the only means of information in the interface (Lidwell et al., 2010).

Color contrasts such as blue and orange are said by Interaction Design Foundation (2021) to create balance in a user interface or to draw attention to a feature in the UI that the designer wish the user to look at. Lidwell et al. (2010) writes about the effect of the colors saturation as colors that are more saturated (pure) attracts more attention than desaturated hues.

Muller (2001) says that to make a color embody an attribute it needs to be put in a correct context and to push that attribute. He continues to say that a color has multiple attributes. The attribute that is emphasized depends on the rest of the context, thus red will be connected with love in the context of roses and a prohibitor when used as a stop-sign.

Orange
Muller (2001) says that orange is experienced as cheerful, warm, approaching, playful and stimulating.

Blue
Muller (2001) says that blue is often experiences as being boring, relaxing, and cool. Interaction Design Foundation (2021) are expressing that blue represents calmness, safety and reliability and when using blue in interfaces users usually feel more at ease using it.

Green
Green, as with blue is also considered to be relaxing, cool and more boring according to Muller (2001). According to Weinschenk (2011) the color green also means "go".

Red
As for orange, red is also considered to be a warm, cheerful, playful and approaching color but red is also assigned with danger according to Muller (2001). Interaction Design Foundation (2021) suggests using red when trying to attract the user's attention or alert about something in a design.

3.2.4 Interface shapes
An interface is affected by how its shapes look and therefore relevant literature on this subject can be used to guide the forming of the shapes in the UI. Here size, shadows and roundness in an interface are discussed.

Size
The success of pressing a button is dependent on the buttons easiness of being pressed and the person pressing skill in pressing, and UIs have the opportunity to improve on the first aspect. According to Dandekar, Raju and Srinivasan (2003) at the MIT Touch Lab, the average for finger pads is 10 to 14mm while the average for fingertips is 8-10mm. This can be taken into consideration when choosing size of button and size of the area around the button. UX Planet (2016) presents statistics that show that a 7mm in diameter button get miss-clicked 1/100 times and a 9mm in diameter button gets miss-clicked 1/200 times and there is not a lot of change in the number of miss-clicks after 9mm in their measures.

For older adults there are more needs to take into consideration. In a study by Chao, Plocher & Liana (2007) testing button sizes and button spacing for older adults, they recommend a button size above 11.43 mm in diameter and over 16.51 mm for high performance. The tests were performed at high pressure as reaction time and accuracy was the tested variables. Caprani, O'connor and Cathal (2012) also discuss touch area sizes for elderly and disables and states that 10 x 10 mm is the minimum size while 20 x 20 mm will have the optimal performance. Parhi, Karlson and Bederson (2006) tested target sizes on small touch screens using the thumb and found that 9.2 mm should be sufficient at doing discrete tasks while 9.6 should be sufficient to do serial tasks without degrading performance

Apple Developer (2021) recommends a minimum size of 44x44px for a tappable area (8.9 x 8.9 mm on a 240x320 px screen) while Material Design (n.d.) recommends a minimum size of 48 x 48 dp for a touch target (9.8 x 9.8mm on a 240x320 px screen).

In summary, sources found recommend sizes from 8.9 x 8.9 to 20 x 20 mm which creates a large spectrum of sizes and for the touchable area, and touchable area should not be mixed with the size of the button which can be smaller. The use case of the button should also be taken into account as a minimum size such as 8.9 x 8.9 mm might not be recommended in a high pressure setting while a 20 x 20 mm button might not be necessary for a low pressure setting.

Shadows
Humans are biased to interpret an object that has dark areas as shadows that are lit from a light source that is above the object and, to humans, interfaces that has shadows below the object look more natural than object that have shadows about the object (Lidwell et al., 2010). Shadow to the bottom left is recommended when wanting a natural and functional design.

By using shadows, the speed and ease in recognizing and finding a component when looking for it increases and by using shadows for a component the user has an easier time to determine if the component can be interacted with according to Material Design (n.d). Shadows also gives the user a sense of depth, movement and where the edges of the object are and the shadows shape determine its location in relation to other components in the UI (Material Design (n.d.)

UX Planet (2016) writes that shadows in a UI with mostly flat design and otherwise flat buttons are called ”floating action buttons” and are used to distinguish themselves as a button to interact with.

Roundness
Researching sharpness of edges Troncosno, Macknik and Martinex-Conde (2008) found that sharper edges require more mental processing than shallower edges. This means that using shallower and rounded edges requires the user to use less mental work.

According to Bar and Neta (2006) they found that ”Humans prefer curved objects”. Their research showed that when users are exposed to objects that are sharp and round they prefer the rounded objects, and they conclude that the shape of the object and its curvature thus has ”a critical influence on people's attitude toward that object”. Feist and Brady (2004) hypothesis that the reason for peoples liking for round shapes is from evolution, that humans have learned that sharpness means danger while roundness promote safety. Science Focus (2017) also discuss why humans prefer roundness and also brings up the evolutionary aspect related to threat and safety and also illustrates an example where five months old babies were exposed to curved and straight lines and showed a preference for the curved lines.

In UI design rounded corners are used a lot. Material Design (n.d) uses rounded corners in their guidelines and so does Apple Developer (2021b). UX Movement (2011) says that ”Designers use rounded corners so much today that they are more of an industry standard than a design trend” and they continue to say why this might be. UX Movement also says that roundness makes it easier to follow the shape and process information as the direction of straight lines can give the eyes abrupt pauses in processing. Designmondo (2016) also discuss the subject of rounded corners in UI and discuss reasons for why they are here to stay; round corners do require less cognitive visible effort from the user and are perceived as friendlier. Designmondo also points out that that the amount of roundness in an interface should depend on the emotions the designer wish the user to have and the identity of the product that the designer wish to be perceived.

3.2.5 Buttons for Interacting
As prototypes with touchscreen and physical buttons will be examined, looking into the literature about their differences can create a more thorough picture about button interaction. This can also be used in making the decision of what is best suited for the product.

According to Reimer, Mehler and Donmez (2014), when comparing the use of tactile buttons and a touchscreen in phones they found that the user did not need to look at the device as much when using tactile buttons. They argue that tactile buttons make it easier for the user to allocate their visual attention. When Zaman, Natapov and Teather (2010) studied performance with touchscreens and physical buttons and they found that handheld device-controls that afford tactile feedback are more efficiently used. They also found that controls which affords tactile feedback is easier to learn and performance increase more rapidly.

Research done by Brewster, Chohan and Brown (2007) on handheld devices show that tactile feedback for interactions make for faster use with less errors. They also found strong results indicating the subjective experience is flavorsome for tactile buttons. This is also shown by Hoggan, Brewster and Johnston (2008) who found that using tactile feedback in mobile devices makes for a higher performance which brings the result closer to physical keyboards.

Nagarajan et al. (2020) discuss that touch controls are replacing physical controls in all fields including medical products due to flexibility, language, functions and ability to handle variations. They continue and say that in many fields' errors can be tolerated while errors for medical devices can cause major issues for the patient and therefore more effort should be put in designing for error predation for medical devices than there might be need for in other devices. This includes choosing the types of controls used for the product. Nagarajan et al. (2020) also says that doing usability tests for the interactions that are used in medical technology is of great importance to ensure less errors and ensure that the designs give feedback on that the interaction has been made.

This research shows that feedback is important for the buttons in order to improve the effectiveness of use and to minimize errors. The button design should therefore provide some sort of feedback and the usability tests need to be performed in order to understand how to improve the product to minimize errors. The theory about interactive buttons also shows that there are pros and cons with physical buttons and touch screen buttons which indicates that the choice should be based on the needs of the situation.

3.2.6 Gestalt principles

Monö (1997) explains gestalt as ”an arrangement of parts which appears and functions as a whole that is more than the sum of its parts. He continues to explain that this means that each element e.g., the colors, materials and shape of an object are not introduced as isolated parts but as a part of the whole.

Chandra (2019) goes on to say that the gestalt principles can be seen as rules that are governing, explaining and describing how the human typically behaves when they perceive the properties of the artefact. Chandra also says that the principles, in nature, very fundamental and can be used as building blocks and that they provide a great rationale to help us explain why a design is easy to understand. Some of the principles are presented below such as the similarity factor and the symmetry factor.

The proximity factor creates gestalts by grouping things that are closer together. By putting things closer together, they appear to have something to go with each other, and the closer together they are, the clearer the gestalt is (Monö, 1997).

The similarity factor is the notion that things that have the same properties creates gestalts and appear to stand out to show that they belong together, for example the markings of buttons. Different kinds of properties can create this gestalt and irrespective of where they are on the artefact clearly show the sense of belonging (Monö, 1997).

The area factor makes the person see the smaller area more easily, and the smaller the area is, the more clearly, we experience the gestalt. This is irrespective of whether the area that is enclosed is the light or the dark one (Monö, 1997).

The symmetry factor says that symmetry creates gestalt. If things are symmetrical, they can be seen as a whole (Monö, 1997).

The inclusion factor creates gestalt for areas that are enclosed. If things are enclosed in different ways, it creates different gestalts (Monö, 1997).

The good curve creates arrangements that we can see. A change in the curve that is significant enough affect how we see the curve and its movement and which parts of the lines that belong together. This gestalt can for example help us to read mosaics and maps (Monö, 1997).

The Gestalt principles are based on how the human process information and by understanding them understandings of the human is also made and using the gestalt principles in the project, the way humans think is taken into account. When dealing with a UI that contains a lot of information that needs to be sorted in order to be understood, the gestalt principles can help to make sense of it all by having rules for how to design.

3.2.7 Design Principles for Interaction Design

In the book "Interaction Design: Beyond Human-Computer Interaction", by Preece, Rogers and Sharp (2002), six design principles are described. They say that design principles are a good way for interaction designers to aid their thinking, and they are thought of as guides to orient the designers for them to think about a variety of certain aspects. The design principles according to Preece et al. (2002) are:

Visibility, the users need to know what options there are in the interface and know how to get access to them. The more visible functions are the more likely it is for the user to find them.

Feedback, an action needs an appropriate reaction in order for the user to understand that something happened. Information about what the user has done should be reported in order to know that an action has been done.

Constraints, restricting the number of things the user is able to do at a given moment. Constrain the interface means to limit the users though process about solving the problem and thus letting them create a solution more in line with the intended use.

Consistency, the same type of action should cause a similar reaction to the interface each time in order for the user to be able to learn how the interface works. An interface that is consistent is following rules that spans the whole interface and is intractable in the same way everywhere.

Affordance, this is the attribute for knowing what to do with the artifact and is giving clues on how to use it in its attributes. An interface with good affordance makes how to do the task more obvious.

Using principles in the project gives direction for designing of the interface and evaluation of the ideas. By understanding them and using them where it is fitting the idea space receives constraints to work inside which push the design towards the principles. These principles are based on human-centered design research, by using them it is then possible to make the interface easier to understand.

3.3 Working with Design

This subchapter brings up topics related to how a design process can be conducted to put the needs of the users in the center of the project. Theory about designing for health and well-being, about Human-Centered Design and about how to reason in design to understand the ideas is brought up. Lastly the design process which is used in the project is explained.

3.3.1 Designing for Health and Well-Being

In the book "Delft Design Guide" van Boijen et al. (2020) says that a "Design for Health and Well-Being" perspective can be used in the process when the goal is an added value for the health of the human. Van Boijen et al. (2020) for example recommends using a human-centered design approach with personas to understand the problems and the user. They also stress that that the designer must know working with designing for health and well-being is a process which is very regulated with ethical considerations and evidence-based protocols and that there are a lot of stakeholders in the process such as patients, assistants and a lot of different kinds of healthcare professionals.

Nagarajan, Silva and Lee (2020) write that when a task requires divided attention (looking at UI, pressing buttons, looking elsewhere etc.) the interactions need to be more intuitive and require less cognitive load than when it is only the UI which is focused on. This is often true in healthcare either when treating a patient that also needs attention or when treating yourself when you also need to feel what is going on. Nagarajan et al. (2020) therefore recommends a stronger connection to the Gestalt principles to separate and group information to be easier to interpret.

This knowledge is used to emphasize that designing for patients' needs also should include to design for others who use, teach about it and have something to do with the product. The solution for how to interact with the Navina Smart should add value to all stakeholders and include them in the process so as their needs also can be filled. This process should thus use a human-centered design approach where stakeholders should be seen as having different needs but where everyone's goal is to treat the patient as nobody is happy if the patient is not treated.

3.3.2 Human Centered Design (HCD)

Norman (1990) says that Human Centered Design is ”an approach that puts human needs, capabilities and behavior first, then designs to accommodate those needs, capabilities, and the ways of behavior. He continues to say that HCD is a philosophy that put the needs of the user first and tests ideas with the users.

Arvola (2014) also points out that putting the human using the product in the center of the development ensures giving value to the artifact that is going to be used in the situation as the product has been tested and iterated to fit in the context and produce something meaningful.

To have a human centered design process, there are three key principles according to Gould and Lewis (1985);

1. ”Early Focus on Users and Tasks”, Designers need to understand the users and who they are in terms of behaviors, attitudes and cognition as well as to study the task that is presented in relation to the users.

2. ”Empirical measurements”, early development should include making simulations of real work and thus prototypes should be made to make this possible and the reactions and the users performance should be recorded and analyzed.

3. ”Iterative design”, this is about fixing the problems that are found when testing the prototypes with users, and this should be repeated as a cycle of design with testing and redesigning.

As the focus of the thesis is to better the situation for the patients using the product, button the needs, behaviors and capabilities of the patient first therefore is a more secure way of ensuring giving value to the user. And by following the principles by Gould and Lewis (1985) a structure for the project in terms of human centered design is created.

3.3.3 Reasoning in Design

Van Boijen, Daalhuizen and Zijlstra (2020) explains that designers process their ideas in four steps which are:

Form, the products material and geometric form is a specific part of the design realized when produced.

Properties, a product has properties which describe the behavior which the user expect from the product in a specific context. The art of designing is partly to understand how properties affect the design such that the design can maximize the positive properties and minimize the less desirable properties.

Function, while a property of a product is objectively true or false this is not always the case for functions. The intentions and goals of the user affect how the functions are experienced. A design can have a multitude of functions at the same time and understanding them in relation to the users makes for a better design as a whole.

Needs and Values, by using a design functions they can realize values and satisfy needs for the users.

The steps of reasoning is thus to give a form that has properties that give functions that can satisfy needs and values. This can also be used the other way around. This model of designing is used to structure the thoughts while designing and structuring the insights which are made during interviews, literature and user testing. Thinking about the way a designer design helps to reflect on levels of reasoning in the design process. As creativity and intuition plays a large role in designing for pushing the process forward, scientific reasoning, a systematic approach and knowledge ensures the reliability of the design.

3.3.4 Basic Design Cycle

Van Boijen et al. (2020) describes the basic design cycle as the way steps and reasoning work in a design process which are repeated with knowledge increasing for each cycle. The process can be seen in figure 5. The five steps as describes by van Boijen et al. (2020) are:

Analyse: examine aspects that are related to the goal of the design and/or the problem that needs to be solved. The analytical reasoning this step provides gives information that affects the requirements for the design.

Synthesise: generate possible solutions and attributes which have potential to be valuable as solutions to the targeted problem.

Simulate: create imagined representations of the designed proposals and simulate the potential for the design, either internally (in the head) or externally to yield representations that can be evaluated to look for potential.

Evaluate: reason about the design proposals potential value using the simulated representations which happens when the proposals are compared to the criteria that are put up about the designs.
With evaluating the designs, they are being understood, and understandings of which solutions that have potential and what needs to be changed in the designs comes forth.

Decide: reason about the value of the design and decide how the process should proceed. Making a decision about the design informs how to proceed with the process and whether there will be a next cycle and what the focus of that cycle will be.

In the thesis these steps are both used as a guide for the whole project but also for the sub parts of the project. The thesis can be seen as both going through this cycle once, but it can also be seen as going through the steps multiple times as this way of thinking is used when doing sub tasks for the whole process such as developing prototypes that is going to be tested and concepts that are going to become the final concepts that are being tested.

3.4 Theory Summary

The theory used in this thesis revolves around the three topics; the human in relation to design, the interface in relation to the human and how to work with design to reach the intended goal. The theory about the human in relation to design explains ways to think of the humans' experiences in relation to design. Mental models, the SRK-model and models of how to think about the humans' emotions and pleasures help in giving the designer a target to aim for with the designs and understandings of what the effect will be. The interface in relation to the human explains how aspects of a design affect the human. It shows that the varying amount of complexity, choice of color, choice of text size and the usage of principles for designing can all impact how the user perceives and learns the design. The working with design theory explains how to reach the intended goal with the design. To receive a human-centered design meant for the healthcare sector; a variety of guidelines, a way to think of the ideas and, a process to go through are used. They all put emphasis on understanding and affecting the user in the correct way which the previous two chapter helps with.

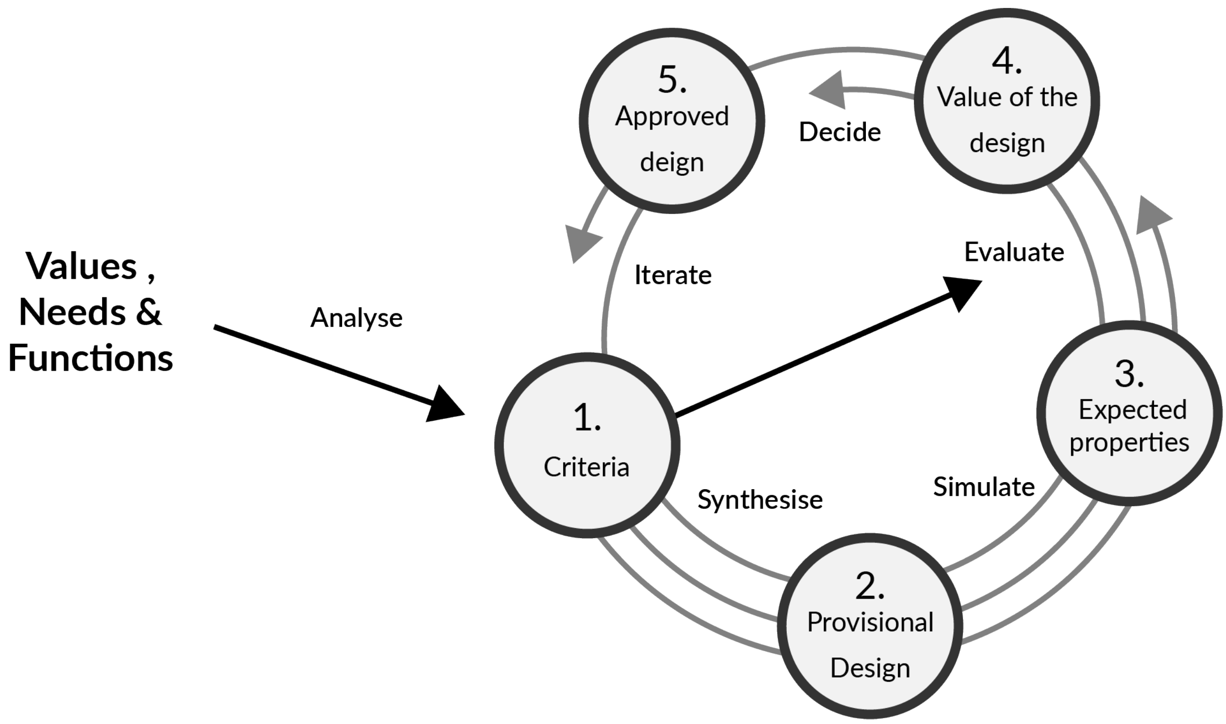


Figure 5: a basic design cycle as described by Van Boijen et al. (2020).

4.
METHOD

The contents of this chapter regard the process of how this thesis was conducted and the methods which were included. The chapter is divided into first explaining the process followed by each block in the process. In each sub-chapter of each block a description of how and why this type of method was used is presented.

4.1 Process

The process of the project is divided into five blocks. The first three parallel blocks' purpose is to create insights about the users, how people interact with this kind of product and what gives the users a sense of control. Then the insights are analyzed, and a concept was chosen. The last part of the process was to create a final prototype based on the insights gathered in the project. The process is visualized in figure 6. A more detailed process visualization can be found in attachment 1.

This process is a result of the basic design process which creates insights, tests designs, makes decisions and finalize the results together with the circumstances of the project. The process had to deal with a lot of things in parallel as one block could not be finished before the others in the beginning. The physical prototype block and interviews block depended on others which created pauses which pushed the timeline forward. The process of booking interviews started immediately but as there is a lot of paperwork, related to GDPR, required to do interviews with users having functional variations, the process of developing the prototypes also had to start simultaneously. The digital prototype was developed and iterated during the same time as the interviews were worked on and the digital prototype was developed with input from the R&D team but otherwise made alone. The digital prototype could therefore be worked on when the other two blocks were paused. The physical prototype was a collaborative effort and was iterated multiple times together with the engineers at Wellspect.

The design process used in this thesis is based on chapter 3.3 which explains how to think about a design in the process and how to design to focus on the needs of the user. The basic design cycle explained in chapter 3.3.4 is as mentioned previously both used on the project as a whole and continiously in the development of the first two prototypes and the final prototype.

The project has explorative, defining and finalizing phases but the process focuses on iterating the results using prototypes to reach a feasible solution that provides good interaction rather than to create an innovative solution. The project is not to create a new type of product, it is rather a new way of interacting with an existing product. The activities that will be performed during the project will both have the purpose of creating user insight to base the design decisions on and to create a creative mindset that can help with coming up with creative solutions. Most activities will focus on understanding the user and understand how the interaction with the product can be improved.

Following is a description of each block and the methods used in them. Some methods are used in multiple blocks and are then presented in the block which the method influenced the most. Each method chapter explains where it was used and each block mentions the methods which were used in that block.

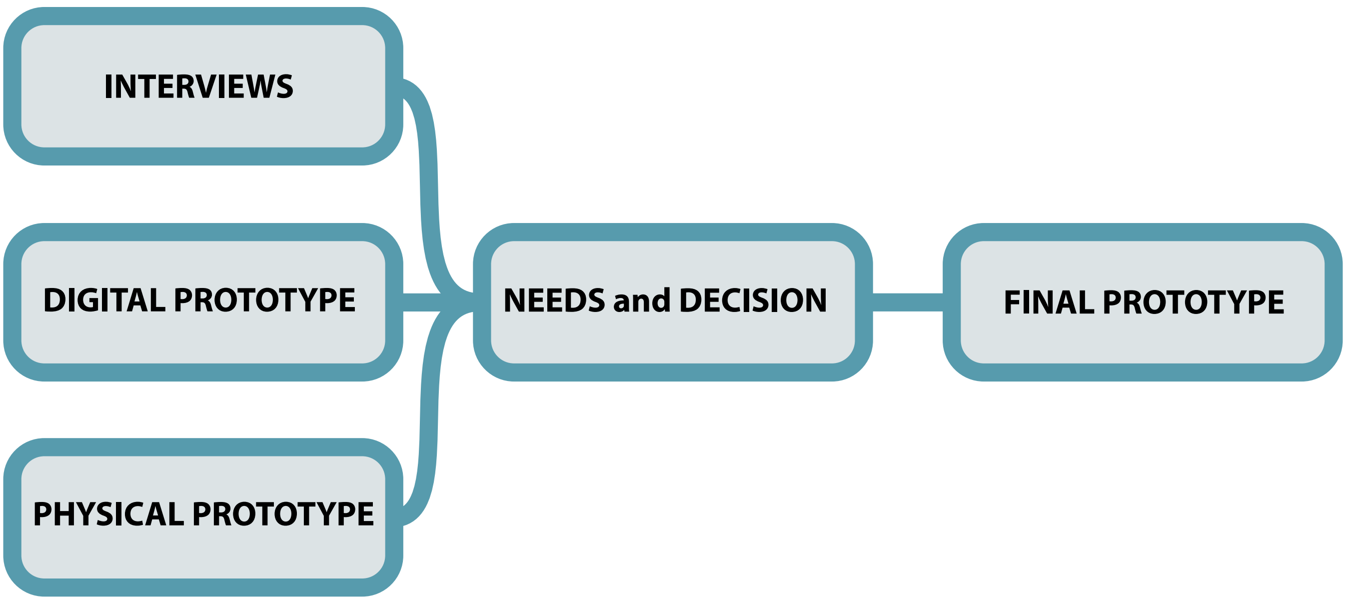


Figure 6: the project process showing the three stages with three blocks with insights, a summarizing block and a finalizing block.

4.2 Interviews and Insights

In this part of the project different stakeholders are interviewed to extract knowledge about the product, how it is interacted with and what feelings the user have towards the product. After interviewing users, sales representatives and a nurse the result was presented, personas were made based on the results and a model for how the users interact with the product was made. This part can be found in chapter 5. Following is a description of the interviewing method and the personas method which was used in this block.

4.2.1 Interviews

This method was used in the interview block as the main method to gain insights about the users of the current product. According to Wikberg Nilsson, Ericsson and Törlind (2015), an interview is performed with the intent to understand the users' experiences, opinions, behaviors and view.

According to Preece et al. (2015), there are four categories of interviews: open and unstructured, semi-structured, structured and group interviews. In the project semi-structured interviews were chosen as the format. This was due to that there were certain areas that needed to be explored and questions where therefore targeting those areas and then talked about freely. And because the initial knowledge of the subject was low a multitude of follow up questions were asked to gain deeper understanding of the situation. Preece et al (2015) says that this kind of interview can take more unexpected turns and thus have a higher chance of grasping valuable information where closed questions might not have reached.

The selection of interviewees was done in order to get a multitude of views on the product. The users view on the experience are seen as the most important, but Nurses, Sales representatives and R&D understand the product in a different way and gets feedback from the users in another way which also can give insight to how to improve the product. In this project there were eleven formal interviews performed with eight users, one nurse and two sales representatives. Because the thesis was conducted as a part of the R&D team they could be asked continuously. Following is a short explanation why each stakeholder is interesting to interview.

Users

This is the main stakeholder that needs to be understood. People in the R&D team express that the individual users experience might vary a lot and that it needs to be taken into consideration. The users have different length in experience with the product and different kinds of functional variations which affect their experience.

Nurses

The nurses might have a more holistic view of the user's experience. They talk to the users before they use the product and therefore know what the users' worries are. They also inform the users on how to use the product and have the most contact with them. The nurses are therefore a great help in understanding the novice users and how they experience the treatment.

Sales Representatives

Information and concerns regarding the product also reach the sales representatives and they might have thoughts that can help understanding the more holistic view of how the product reaches the user. This can give insights on which are the main concerns that bounce back all the way to the sales representatives. It is also interesting to know which aspects of the product that the sales representatives believe is most important to express when selling the product and who they think is using this version and why. Knowing how the sales representatives wish the product should be in order for them to be able to be proud in selling it to customers is also interesting to get to know.

R&D

The R&D team is interesting to understand because they are the ones developing the product and choose what to prioritize to fix. They receive feedback mostly through sales representatives, but they also receive feedback through data collection which they then interpret. It is valuable to gain understanding of what they think of the product now and what they wish the product to be in the future. No formal interview was made with the R&D team, but they were communicated with continuously throughout the project.

4.2.2 Personas

This method was used in the interview block as a method to understand the interview material easier.

The result was then used in the User Needs and Prototype Decision block to guide the decision and the design guidelines In the Final Prototype it was used to guide the design of the final prototype.

A persona can be a powerful tool to communicate a uniform view of the users' behaviors, prerequisites and characteristics if the personas are based on information that is collected in the project (Preece et al., 2015). Personas are fictive characters that describe the users in the project (Wikberg Nilsson, Ericsson, & Törlind, 2015). Personas makes the communication of the users' needs more human than looking at data. The designer's task is to develop a solution that can match the requirements of the target users and by using a persona the designer can more easily put themselves in the user's state of mind and therefore be more empathic towards the user.

Personas were created when the realization that there are multiple factors making the users different. To take a lot of information concerning the users into consideration when designing, such as function variation and experience, the personas were made to summarize this. By creating the personas, the attributes of the users can be thought of while developing the concepts and used to evaluate the ideas.

4.3 Digital Prototype Tests and Insights

In this part a digital prototype was developed to be able to perform user tests. This also included to design a test and write interview questions to extract information. When it all was finished the test was executed with eleven participants. The digital prototype was made to test the interface with inexperienced test persons and to compare a concept with a large screen and a smaller screen with three fixed buttons.

4.3.1 Design Drawing to Develop

This method was used in Digital Prototyping and Insights block, the Physical Prototyping and insights block and the Final Prototype block to come up with ideas and develop them.

Van Boijen et al. (2020) describes the method of design drawing to develop as a way of asserting and addressing creativity where all the thoughts about the design can be explored. This method lets the designer to compare the ideas, present them and assess them while reflecting, thinking and developing the ideas more. Van Boijen et al. (2020) continues and says that the method is serving as an exploratory and communicative tool with visualizations as language, and the process can concern anything that is relevant for the project such as aesthetics, shape, interaction or use. In the thesis this method was used in all stages of the project. Drawings were used to communicate the prototype ideas with the rest of the R&D team and to communicate with the testers when presented to them. It was also used throughout the process as an exploratory tool in the developing of ideas and iterating them. This method was both used on paper for the first stages of the ideas and then in Adobe Illustrator and Adobe XD to make them higher fidelity and to iterate.

4.3.2 User Testing

This user testing method was used during the Digital Prototyping and Insights block and the Physical Prototyping and Insights block to better understand how people interact with the digital interface and with two kinds of buttons.

User testing can be performed in different environment such as laboratory or where the product is usually used and the test persons can include the target group for the product, experts in the field or people who are unaware of the product (Osvalder et al., 2015).

Osvalder et al (2015) says that it is enough to test with five to six people to find 75-80 precent of the issues while it is preferred to use a user group of six to eight individuals with similar skills in relation to the product. Norman (2013) express that it can be enough to use five individuals for a user test to be able to identify findings regarding the product.

Evaluating a product concept is according to Van Boijen et al. (2020) a way to help designers understand how the user value the designed concept. Evaluating the concept makes it possible to determine the aspects in the concept that needs to be changed or removed and if there are things that needs to be added. When evaluating the concepts, it is important to have an open mindset and not be biased towards a concept. An evaluation can be done both in order to choose between concepts or to evaluate a concept for further development. Van Boijen et al. (2020) suggests the following eight steps to be performed for a evaluating a concept:

1. Formulate the aim of doing the evaluation.

2. Determine the type of evaluation that wish to be performed.

3. Develop a representation of the concept that is appropriate for testing.

4. Create an evaluation plan consisting of the aim of the test, type of evaluation, questions for the test persons, the intended test environment and how the test should be recorded as well as a plan for analyzing the results from the test.

5. Search for and invite people to the evaluation.

6. Set up the environment to test in.

7. Conduct the evaluation of the concept(s).

8. Analyze the results that are recorded from the test and present them to be easy to interpret.

In this thesis these steps were performed two times, once for the physical prototype and once for the digital prototype.

After a user test Norman (2013) express that it is necessary for the test leader and the person who has performed the test to have a discussion to reflect about the steps that were being performed in order to understand and get more insights about the users experience of the test.

In the tests, novice users were used as they would have the most difficulties with the interface and thus be able to identify issues for novice users. Because symptoms can happen to anyone that gets a type of illness or gets into an accident, anyone can be regarded as a potential user. The tests were performed in a lab environment where the user had only either the digital or the physical prototype on a desk in front of them with the lab instructions. As the product regards a very private matter which includes inserting a catheter rectally, the test was not used for the intended purpose which would require a more developed prototype, experienced users and a lot more paperwork. The test used 11 testers for both the physical and the digital user test and patterns could be seen already after about five tests as Norman (2013) said but as there were numeric data collected from the tests. Because the digital prototypes focused on flow but also on detailed information it was beneficial to have more users to notice imperfections in the prototypes.

4.3.3 Digital Prototype Testing

Digital prototypes were used in the Digital Prototyping and Insights block where this was the main method which contributed to easy prototyping and realistic interactions. The Final Prototyping block also included making digital prototypes but no tests were performer in that block.

A prototype can be used for a variety of purposes, and when using a prototype that is made to test a function it should try to replicate that function of the system. Wölbling, Krämer, Buss, Dribbisch, LoBue and Taherivans (2012) says that when a designer works on a prototype for a user interface the fidelity of the prototype improves continuously and in this step the prototype goes from being sketches into being more similar to what the final product would look like. In this project, a lot of constraints is already put on the interface to what it should contain and what the function of the product are, this pushed the needed fidelity of the prototype forward as there are more details that overall picture which is being tested.

There is a natural step for the development of a UI prototype where the design goes into being interactive which usually is done in a digital prototyping tool (Wallach & Scholz, 2012). The feedback that can be reviewed from the user that the prototype is tested with is more direct, reflective and is easier to communicate. The digital prototypes let the user engage in the product and its interactions according to Wallach and Scholz (2012). The engagement partly comes from that a more real interaction is less abstract which can create more richness and clarity in how it is supposed to work. Making a more high-fidelity digital prototype for the thesis thus made it possible to focus on the ease of use to perform certain tasks and the ease of understanding for new users because the overall concept is more or less set. This was good as it was not possible to meet the actual users of the Navina Smart to test and therefore users who do not have knowledge about the product was tested with. A total of eleven user tests with the digital prototype was done and the interactive prototyping tool Adobe XD was used. More about the process of making the digital prototype and testing can be found in chapter six.

4.3.4 Adobe XD and Adobe Illustrator

In this thesis, the computer software Adobe Illustrator and Adobe XD were used. Adobe Illustrator was used to develop more complex figures as it has more tools for that while Adobe XD was the mainly used program. Adobe XD also provides tools for making interactions in the UI and to make variations of screens at fast pace, the program also has an app which was used to view the prototype in a handheld to interact with it. The app was also used for user testing the prototype.

4.4 Physical Prototype Tests and Insights

In this block a test to be able to understand the difference in control, and experience from using physical buttons and from using a resistive touchscreen was designed. To do this, two physical prototypes was developed together with two engineers at Wellspect. A set of interview questions were also used which were asked after each participant had used the prototypes. The test results were then presented to be used to develop the product further. This part can be found in chapter 7.

Methods previously mentioned which also are used in this block are: Design Drawing to Develop (4.3.1), User Testing (4.3.2). Other methods used are explained in the following two sub-chapters.

4.4.1 Physical Prototype Testing

Using physical prototypes was done in the Physical Prototyping and Insights block where this was the main method used to gain understanding of how the users interact with two different kinds of buttons.

Van Boijen et al. (2020) writes that 3D physical models can be used to simulate concepts and product ideas and they also say that a generalization of physical prototypes is that there are two types, ”looks like”, and ”works like”. In the case of this thesis a ”works like” prototype is developed as it does not look like the intended final result but it provides the same kind of result in terms of functionality. Van Boijen et al. (2020) explains that when using prototypes to test and verify ideas there are often simplifications made and the level of detail is often determined by what is required by the stage in the process.

Using a physical prototype in the project was done as the physical feel in relation to the task was a question which was raised. By having a prototype which performed the actual action such as inflating and deflating the balloon and irrigating water the physical prototype could examine the users experience in relation to the particular actions. Simplifications were made to the prototypes; in this case they were made to focus on evaluating the feedback of the two kinds of buttons which resulted in a simple UI that only gave feedback on the pressing and no other information or menus etc. More about the process of making the physical prototype and evaluating it is found in chapter six.

4.4.2 3D printing

Greenhalg (2016) writes that ”…3D printing allows the direct creation of objects from 3D computer-aided design files”. He also compares 3D printing to other methods of making models and says that 3D printing improves the designers’ models in a rapid prototyping setting and in particular it is improving the ability to replicate the same kind or versions of the same kind of model in an accurate scale and with detail when comparing to model making techniques that are seen as more traditional.

Van Boijen et al. (2020) says that 3D printing lets the designer iterate concept shapes multiple times. This method of prototyping for the physical prototype was done as it made it possible to iterate the design of the test rig when communicating to the engineers about how things needed to be made in order for everything to fit together.

4.5 User Needs and Prototype Decision

In this part of the project the insights from the three explorative blocks were summarised in requirements and focus areas for the next version of the product. The two different concepts were then discussed based on the knowledge gathered in the first three parts and the requirements and focus areas. Then design guidelines which are to be used when designing the final prototype were made which are based on the interviews and literature. This part can be found in chapter 7. Following is an explanation of the three methods used in this block.

4.5.1 Literature Study
The literature study method has been used mostly during the User Needs and Prototype Decision block and the Final Prototype block as more literature had been read at this point and more knowledge about what literature to look for had been gained. It has also been used to a lower extent during the first three blocks to get some information regarding how to design the prototypes.
According to Milton and Rogers (2013), there are five steps that needs to be followed when conducting a literature study;

First, the problem needs to be formulated to know what kind of literature to look for.

Second, collecting data need to be done where a large quantity should be gathered.

Third, evaluating the quality of the data where more evaluation leads to use of higher quality theory.

Fourth, analyzing the data, choose the most relevant and present it.

Fifth, give the data your own take to show that you have understood it correctly.

The covered literature can be found in chapter three and mainly concern usability in interfaces, meaning of aspect in an interface and how to receive a human-centered design. Books, scientific articles and web sources were used as literature. Search words which were used to look for literature were: human-centered design, human-computer interaction, color and meaning, shape and meaning, user errors, learning interface, usability and design thinking. Chalmers Library, ResearchGate and Google Scholar were used to search for the literature.

4.5.2 Problem Definition
Problem definition as a method was mainly used in the User Insights and Prototype Decision block to gather the insight's and understand what the issues are and what is needed to be done to solve those. The method was also used in the Digital Prototyping and Insights block and the Physical Prototyping and Insights block where it was used to define what the tests were meant to test by affecting the instructions and methods of evaluation to acquire the intended information from the tests.

As designing can be considered a type of problem solving it is vital for the designer to understand what the problem is in order to work on the correct problem (Van Boijen et al., 2020). Appropriate and innovative solutions to the users' problem comes from working with the right issue and thus it is crucial to create a definition of what the designers should work on. The formulation of the problem should also include aspects and arguments that provides strength to why this is a correct definition.

In order to be able to define the problem the designer must firstly gain insights about the user and about the problem(s) that the user wish to be fixed. Included in the definition of the problem is also to define a scope of the problem where a wide scope might create to many opportunities while a too narrow scope might create too few (Van Boijen et al., 2020).

Using this thinking of creating a problem definition to target the correct problem has been used multiple times in the process, when starting the process in defining the projects problem, when designing the user tests to understand what problem which is tried to be understood and after gaining a lot of insights to know what problems the final prototype should aim to solve.

4.5.3 List of Requirements
This method is used mainly in the User Needs and Prototype Decision block to define what the final prototype should include to attend to the needs of the users. A less defined variant of the method is also used in the Digital Prototyping and Insights block and the Physical Prototyping and Insights block when selecting what the prototypes need to include.

This method states important aspects about the design that needs to be present in order for it to be successful and this method can be used in order to design proposals or combination of proposals (Van Boijen et al., 2020). This method is being performed after gaining understanding of the problem(s) and it helps in creating boundaries for the design process and it can be updated as the design process gets further. In the project, the method is used to create guidelines for the design and to translate the insights and needs to concrete attributes for the interface. The requirements are based on insights from users, literature and the company.

4.6 Final Prototype

The last part of the process was to create a final prototype which is based on the insights from the first three parts and the design guidelines created in the part before this. The prototype is made to show how the insights has affected the interface and to be able to test with the users to continue to iterate the product. This part can be found in chapter 9.

Methods which are mentioned and are also used in this block are: Design Drawing to Develop (4.3.1) and Literature Study (4.5.1) but this chapter mostly was influenced by the insights from the previous four blocks.

5. INTERVIEWS AND INSIGHTS

The chapter presents the results from the conducted interviews with eight users, one nurse and two sales representatives. Three personas based on the results of the interviews are presented as a representation of the users. A model for what feedback is received by the users and how they can interact with the product is also created as a tool to understand the user's relation to the product. Figure 7 shows that this is one of the three phases which are done to create insights about the product

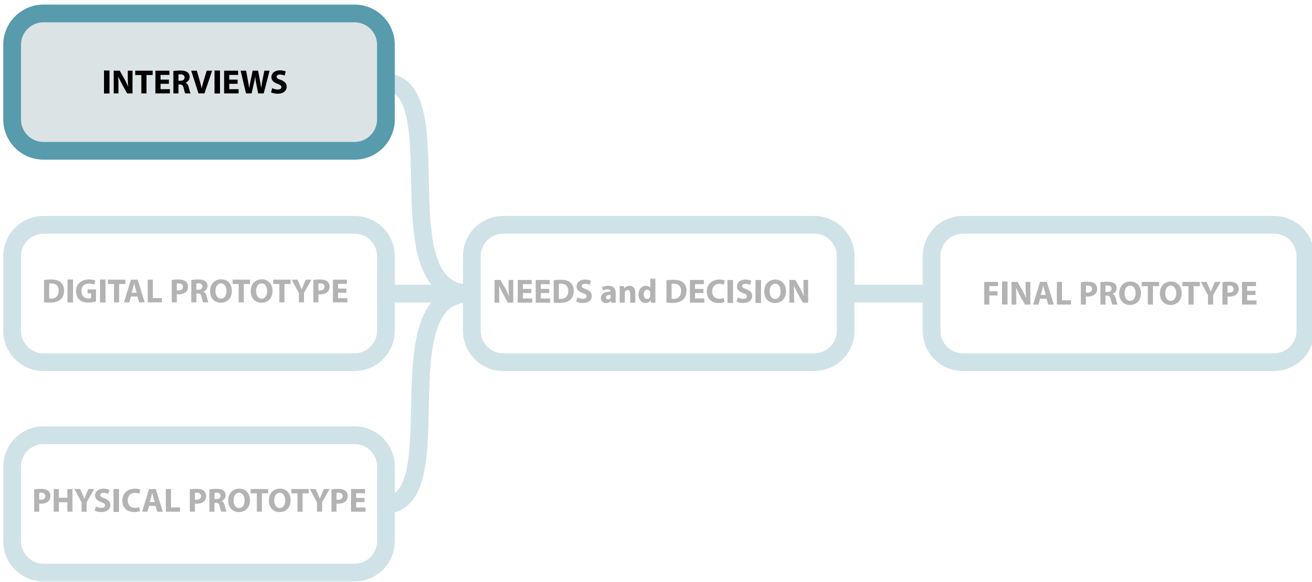


Figure 7: showing that it is the Interviews and Insights part of the process this chapter is presenting.

5.1 Interviews

The interviews were conducted via video calls to be able to see each other without the need to meet in person. The interviews were done with one nurse who work for Wellsepct, two sales representatives at Wellspect and eight users that are using the Navina Smart currently. The data derived from the interviews are presented in appendix 5. Following is a summary for each category of interviewees and then the key insights related to the user interface development is presented.

5.1.1 Nurse

The nurse's viewpoint on the users and the product is different from the other stakeholders because they have education in transanal irrigation treatment, and they meet with the users when they are new to the treatment. The nurses are also the closest link to the user.

The interviewed nurse expressed that reliability of the product used to be the biggest problem and that the users tend to be in a wheelchair or have a hand disfunction. Experienced users tend to want to make the treatment faster and when they encounter problems it is usually because they have skipped a step. Newer users are more insecure about how to do the treatment but are willing to learn.

Regarding changes that the nurse would like to make to the current unit. She would like it to be smaller to be easier to carry and to have a touch screen. The users already believe it to be a touch screen when they first encounter it. She also mentions that users find the buttons annoying, especially to hold for a period of time but that she herself think it is good that the buttons need to be held down.

5.1.2 Sales representatives

The sales representative's viewpoint of the product is from an economic and informative perspective. While they try to sell the product, they are also possessing a lot of information regarding the product and nurses and sometimes users come back to them with questions and issues regarding the product.

When selling and informing about the Navina Smart unit the sales representatives focus on the unit's ability to function for people with hand dysfunctions and that the type of treatment helps to take control over your life situation. The sales representatives have also seen that some users want the product because they like technology. When it comes to the usage of the app, they do mention it when selling the product. However, they say that the best argument for using it is to contribute to research about the bowel.

Issues that the sales representatives have seen are that the units break down and does not work and that the interface is perceived as old. The usability of the product does not seem to be a big issue according to the sales representatives.

Changes that the sales representatives would like to do is to make the unit more reliable in terms of breaking down and error messages. They also would like to make the error messages easier to understand and easier to act on whether it is to turn off the unit or to just close the error message.

5.1.3 Users

From interviewing the users, it was shown that the way that the users are using the product both differ in method and in settings. Users from this sample also differed in type of disability and level of hand function. The users in this sample are using the product every day or every other day and when using the product, they irrigate from one to four times with one time being the most common. The water amount used in the treatment varied from 250ml to 900ml, the water speeds varied from one to five and the balloon sizes also varies from one to five. The time for starting the treatment to finishing is from 20 minutes to 50 minutes from the interviewed group. The variety in settings shows that there is not one recipe that fits everyone, instead every user finds their own way of performing the treatment.

Out of the users that were interviewed, three users have normal hand function, three have lowered hand function and two are paralyzed. The users also had different functional variations such as spinal cord injuries, bowel disfunction and neurological issues. Some of these issues has resulted in them using a wheelchair. The users experience in using the unit differs based on the abilities of the user. Some have no trouble using the unit, some experience issues with holding the unit and pressing the buttons and, some need help from assistants to be able to perform the treatment. When pressing the buttons all users but one pushed the desired button, water or air, and held it down until it reached the desired amount. One user held and waited more carefully to reach the desired amount of air and water.

The positioning of the control unit and the water container differed between users. The control unit is placed in the lap, around the neck in a strap, on a wheelchair or on a table in front of the user or most commonly, in the users' or assistant's hand. The positioning of the water container differs between the users, some place it on the floor and some on a table, stool or wheelchair in front of them.

When talking to the user, they express that the TAI treatment and the Navina Smart unit has transformed their lives and that they can live a more normal life since starting to use the product. Users express their liking in that the unit is easy to understand, easy to instruct others in using and, that the product is good for people with lowered hand function.

"Saved my life"

The most reoccurring problem among the users is that the unit breaks down and that the user then has to order a new one and be without the unit for a short while. The users also do not understand why their unit breaks down and can therefore not do anything to hinder it from doing so.

The touch buttons are also considered a problem for some as they experience them not to respond sometimes if they do not put the finger on the touch area in a correct way. Users also experience the buttons to not respond if the finger is too wet or too dry.

Users also report that error messages appear when using the unit. When the error messages appear, the user needs to read in the manual what the error number means, and this also might not indicate what to do about the issue. Experienced users do not bother to understand what the error message means and instead just restarts the unit, which can be frustrating. This also does not allow the user to learn what to do to hinder the error message from appearing. One user also expressed that the unit is difficult to instruct to assistants as the buttons and interface do not have distinct symbols and colors to distinguish them from one another.

"Difficult to instruct assistants"

There are a few things that the users do the same; when they have found a desired way of doing the treatment and settings, they prefer to not change any settings or change the way they do the treatment.

The way they conduct the treatment is set. Six out of eight users interviewed, uses one water speed for the entirety of the treatment while the other two uses a slower speed at the beginning and increases after a short while.

According to some of the users the main reason for looking at the screen during the treatment is to see the numbers that are indicating balloon size and water amount. Some also express that they are interested in the water speed since it is lowered if the pressure in the bowel is too high.

When the users get asked about how they experienced the product when they were beginners some express that there were no problems, some that the order of the treatment is illogical and some that they feel like some information is missing.

”The app is not necessary when everything works”

Talking to the users it also becomes apparent that some information and functionality is unknown to some of them. One important feature that were unknown to many is that if the balloon has stopped to inflate due to high pressure in the bowel, it can be deflated fully and then inflated again. Not knowing this has resulted in many users turning off the unit and then turning it back on to reset the balloon.

5.1.4 Insights related to UI

The information from the interviews is almost all related to the user experience but the main insights that will be focused on are those related to the UI and the scope of this project. The remaining insights will be presented to Wellspect for them to act on. The key insights drawn from the interviews regarding the users and their relation to the UI are:

- Users can vary in their abilities to use the product. Some users have spinal cord injuries and are in a wheelchair while some do not have any disabilities except for their bowel. The users also vary in their hand function as some have no problems while some others are paralyzed. There are also cases when it might not be the person receiving the treatment that is operating the unit, rather a personal assistant is operating it.

- The users express that the unit is life changing and their general feelings towards the unit is positive because of its impact on their lives.

- Novice users might experience the treatment as intimidating and that that there is information lacking in how to perform the treatment, but a lot of users cannot recall any problems.

- Experienced users feel secure in their way of doing the treatment and they have their own methods of dealing with problems that might occur.

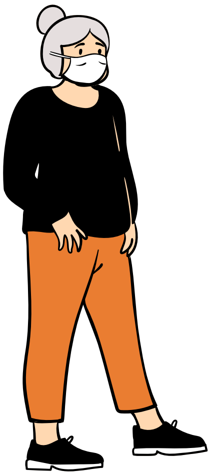
- The buttons on the unit are both liked and disliked by the users. The liking of the buttons come from the lack of pressure needed to keep it pressed. The dislikes come from the difficulty in using the buttons as they need precise placement of the fingers and may not respond with too wet or too dry fingers.

- Error messages popping up while doing the treatment and the difficult in interpreting why they are doing so is an issue that is present for experienced and novice users, where novice users want to learn why this happens and experience users usually ignores them.

5.2 Personas

The personas are used, in this projekt, as a measure to push the user perspective into the design and not only as user data but as a person using the product. The personas also show that there is a variety of users in terms of age and function variation but that there is a focus on hand disfunction. Another focus area is to be able to use the unit efficiently by an assistant to the person receiving the treatment.

LISA
USER



Lisa started to use the Navina Smart unit after a surgery that affected her neurologically and thus her bowel in this case. Becasue she feels weak in her hands she opted for the Navina Smart unit.

Age:
57.

Tech skills :
3/10

Function variation:
Neurological.

Hand Function:
Okey, but weaker.

Time Using Navina Smart:
3 years.

Frustrations:
Unit showing error messages and breaking.

Additional information:
Is kind of an ambassador for the product.

Figure 8: the persona Lisa.

SUNE
USER

Sune got into an accident and now has a spinal cord injury that affects bis bowel system as well has his hand functionality.

As the Navina Smart unit is better to use for assistants it is the unit he is using.

Age:
23.

Tech skills:
5/10

Function variation:
Spinal cord injury.

Hand function:
Paralyzed.

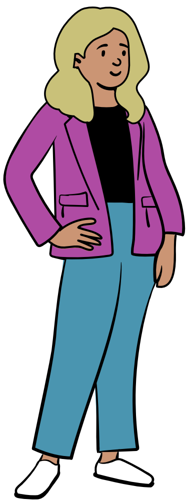
Time Using Navina Smart:
<1 month

Frustrations:
Lack of instructions.

Additional information:
Needs assistance using the product.

Figure 9: the persona Sune.

MAJKEN
ASSISTANT



Majken works as a personal assistant to people with different needs. Sometimes the person has a medical device that Majken has to help them use. When it is a device she have not used before the user has to describe what she needs to do to her.

Age:
32

Tech skills:
7/10

Time Using Navina Smart:
About 20 times.

Frustrations:
Unit showing error messages and difficulty in understanding the users' instructions.

Additional information:
Is very dependent of the person getting the treatment.

Figure 10: the persona Majken.

Lisa, the user in figure 8 shows that having weaker hands can be enough reason to choose the Navina Smart unit instead of another transanal irrigation treatment product and Sune in figure 9 show that the user can have a lot of complications and need assistance.

The persona created for the assistant, in figure 10, is more speculative than the others as it is based on a third hand source, users in the interviews talking about their assistants and their issues. It is necessary to acknowledge the assistants as user in this case as they will interact with the product and by creating a persona, they will be easier to take into consideration.

Frustrations differ as more novice users might have more trouble with functionality and understanding how to use the product while more experienced users might have more issues with that the product just is not working as they want it to.

The personas show the span of users and their differences. The personas will thus help the design to think of all the variations of use cases that there are, both in terms of function variation but also in terms of experience with the product and their technology proficiency.

5.3 Cybernetics and feedback

When exploring the user's sense of control, it is important to think of how the user can affect their way of doing the treatment and how they can feel in control. According to Werner (2017), cybernetics is studying the users when they have a goal and take action to achieve this goal. It is this point of view that is explored in illustrating the actions that the user can take in the treatment. It also illustrates what feedback the user can achieve and then achieving the goal of reaching their desired balloon size and water level. This illustration can be seen in figure 11. The illustration is made of when the user is doing the treatment (inflating and deflating the

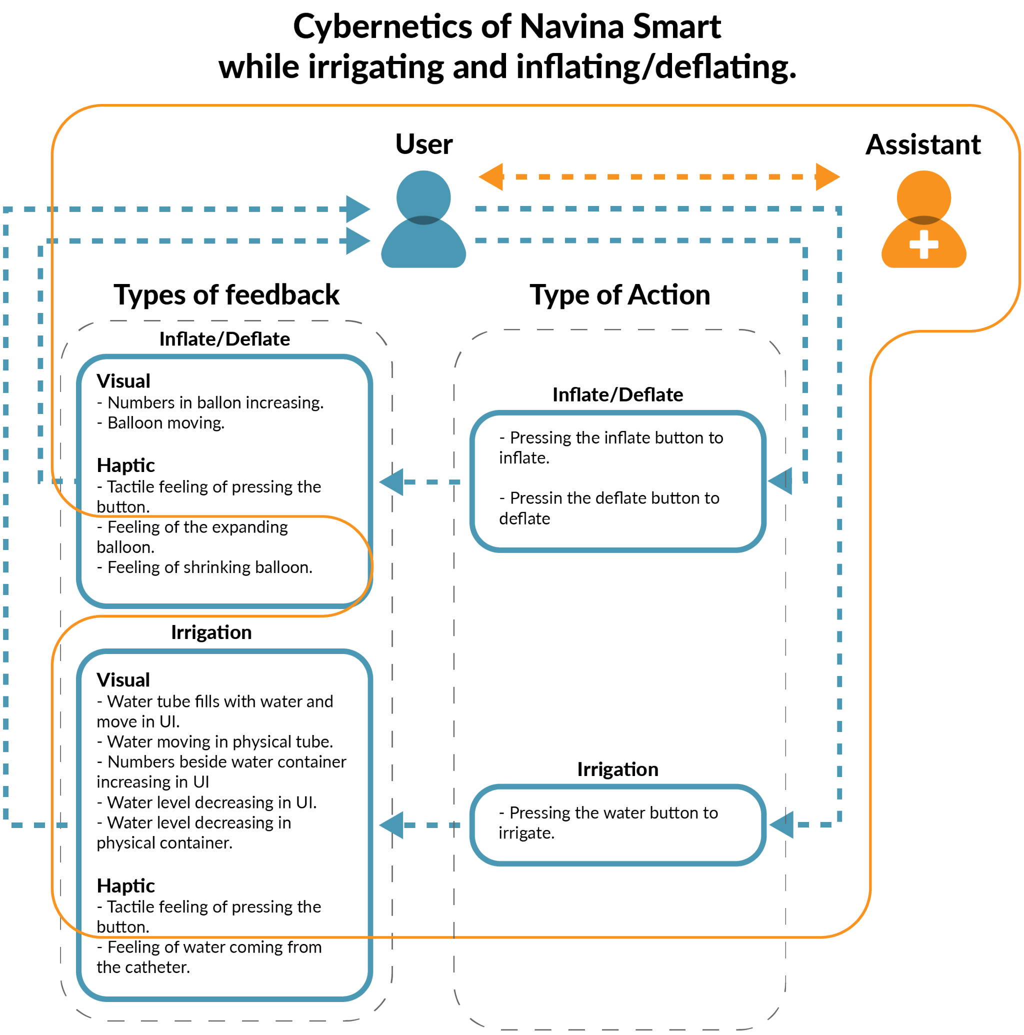


Figure 11: cybernetics for Navina Smart in relation to the user and the assistant.

balloon and pumping water) as this is where most control is needed.

Looking over the user's cybernetic it is easy to see that the user has just a few actions to take but there are many things that can give him/her feedback on what is going on. Some feedback only shows that something is happening. Examples of this is the water moving in the tube, in the UI, and the balloon moving, in the UI. Other feedback is indicating the progress such as the water level moving and the numbers increasing for the balloon size and water level. Although there are a lot of feedback given about that the user is doing something and the progress, it is not the same for everyone. Some users have diminished feeling in their bowel, and some do not have any feeling there at all and thus the feedback of the balloon increasing, and water is pumped in is not the same. They instead have to rely more on the visual feedback.

If the person doing the treatment has an assistant helping, the assistant is also part of the cybernetic system. Because the assistant is not receiving the treatment s/he do not get the feedback from the balloon expanding and water pumping into them. The assistant instead relies on the visual feedback from the unit and feedback from the person receiving the treatment, who might tell the assistant something about what is going on. The assistant can also request more feedback from the person receiving the treatment by asking things and thus get more understanding.

Even if there is a lot of feedback that can be receivedby the user the feedback can be better or worse. The current model of Navina Smart has multiple ways of giving feedback and thus it is more the quality of the feedback that the unit gives that is worked on rather than the number of ways the person using the unit can get feedback. The feedback quality can be improved everywhere from button pressing to how the visual feedback on the screen is presented and all aspects are relevant to the thesis except for the feedback received from feeling balloon expanding and the water getting pumped up.

5.3 Interviews and Insights Summary

The chapter involves interviews with different stakeholders and insights gained from them. The interviewed users are shown to have a variety of issues when it comes to their ability to use products with their hands and to move around. The issues experienced also varies from when the user is new and when the user is experienced. New users have issues with the treatment itself and the ability to use the product while the experienced users usually only have errors messages which they are able to solve without being bothered too much. Most users also have a similar approach to the product which is that they want it to be something they can solve a problem with and have to think about as little as possible.

From the insights gained by the interviews three personas were made. They are used in order have a more human way of putting the user data in relation to the designs. Based on the interviews a cybernetics representation to understand the ways the users can receive feedback and when they perform actions in the treatment also was made.

6.
DIGITAL PROTOTYPE TESTS

In this chapter the testing of the digital prototypes is presented. This regards the development of the digital prototype, the execution of the test and the result of the prototype. As shown in figure12, this chapter is one of the first three blocks which are made to gain insights into how the product is and can be used.

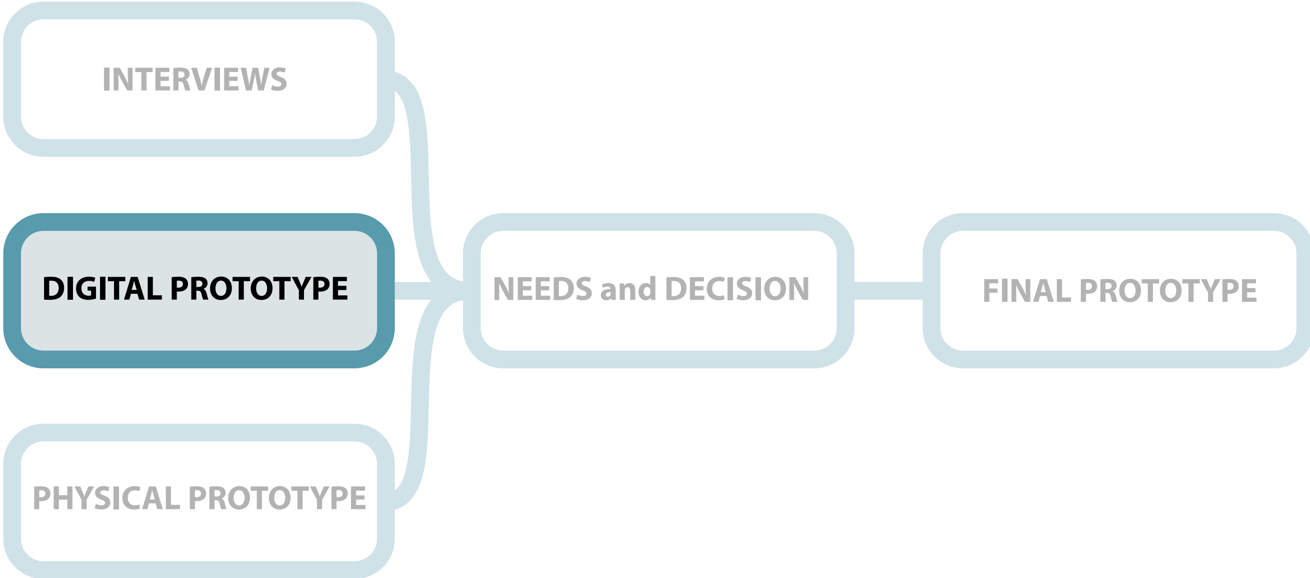


Figure 12: showing that this chapter is one of the first three blocks in the process of the thesis.

6.1 Digital Prototype for Testing

The first digital prototype was developed to test a version of the digital interface to gain insight into what is difficult about the workflow and what is easy to understand. The prototype was developed in Adobe Illustrator and Adobe XD which made it possible to test the UI on a smartphone.

The decision to not integrate the UI into the physical prototype to test on actual physical buttons and the resistive touch screen was made to have a more secure scope in terms of time. The development of the UI for the physical version would be made by software engineers and the development would be partly out of control. The prototype would also only be used in the user test which made it more unnecessary to take up a lot of time from others in the company to make the prototype.

The prototype was made to be able to make a standard treatment with the addition of going into settings and make a review of their performed treatment in the UI. The basis of the design was the existing interface of the current Navina Smart unit but with improved graphics and added functionality. Two versions of the interface were created, one with a fixed set of buttons that should represent the physical buttons version and one version with no fixed buttons and a larger screen. Some of the screens in the user tested interface will be presented below.

6.1.1 Only Screen

This version uses a larger touch screen and thus has more space that can be changed between stages. What this version of the interface will evaluate is if the larger screen has any benefits and, if there are any, how great these benefits are. The larger screen enables the user to have larger buttons in some screens which enables easier pressing of the buttons and larger text and icons. Twelve pictures from the version with a big screen touchscreen can be seen in figure 13.

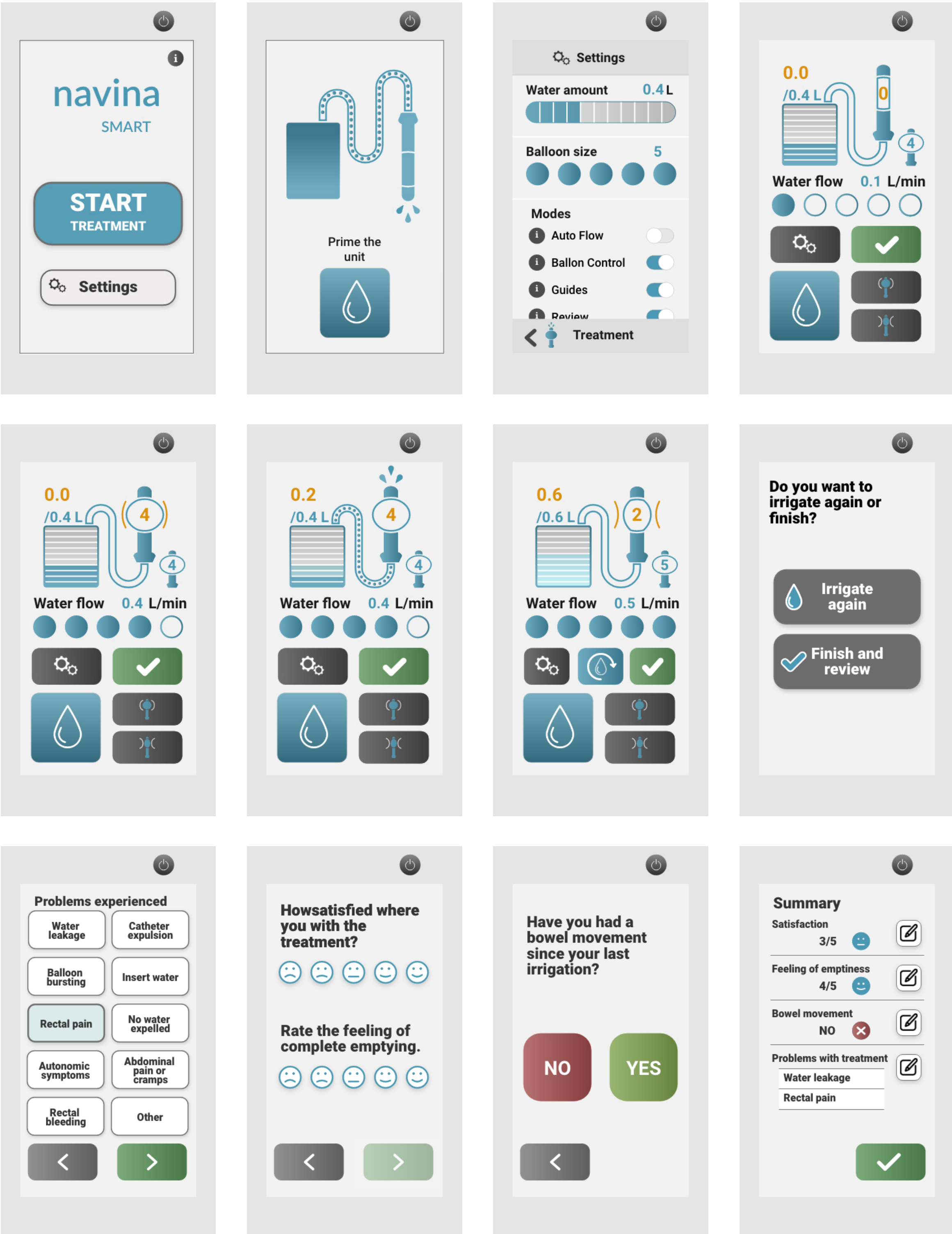


Figure 13: sample of screens used when testing the digital prototype for the version with a larger screen.

6.1.2 Screen and Buttons

This version uses three fixed buttons and a smaller touchscreen that are there to simulate how it would be to have fixed physical buttons in the UI. The buttons that are chosen for this interface are based on the current Navina Smart buttons but with only one large water button instead of two smaller ones as the button can be made larger. The water button and the inflate and deflate buttons are chosen to be the physical buttons. These three buttons are the most important ones to have as physical buttons as it is while using them the user is expected to be in most need of control over their actions. The actions are to inflate and deflate the balloon and to irrigate water. The other actions the user makes can be put on the screen as they are not interacting with the body. Twelve pictures from the version with a touchscreen and buttons can be seen in figure 14.

Figure 14: sample of screens used when testing the digital prototype for the version with three physical buttons.

6.2 Digital Prototype Test

The test of the digital interface was done in order to investigate multiple things related to the interface. The reasons are:

1. To test the difference in designing and using an interface with a larger touchscreen screen that can be adapted and a combination with physical buttons and a smaller screen.

2. To test what the difficult parts of the interface are.

3. To understand how different symbols are interpreted by the user.

4. To understand how different sizes of the buttons and infographics affect the use of the interface, this is connected to how the two different interfaces are made as the one with the larger screen as some larger buttons and illustrations.

5. To understand what initial thoughts about the design work and what ideas that does not work.

In short, the test is done to get feedback on the designs and thus to learn how to improve it. Following is a description on how the test was made and the results of the test.

6.2.1 Digital Prototype Test Execution

The test was made with eleven individuals that had little or low knowledge about the UI. The UI that was designed in Adobe Illustrator and Adobe XD was opened in the Adobe XD app and was thus able to being used from there. The test performed basic tests in the interface expected to be performed by a new user. The test person started the unit, primed the unit (removed air from the water tube), did two irrigation at different balloon sizes, water amounts and water speeds. The user also went into settings to change a few things and finally did a review on their treatment. The steps in which each test person was to perform the test can be found in Appendix 6.

While performing the tasks notes were taken. If the test person had difficulties with a task and asked for help, they received verbal guidance and the area of difficulty was noted. After all the tasks were performed with both interfaces an interview with questions related to their experience with using the prototypes were conducted. The interview questions can be found in Appendix 6.

6.2.2 Result from Digital Prototype Test

The result from testing the digital prototype revealed a lot of information both from observing the users with the interface and from the interview regarding the interface. In Appendix 8 the full transcripts

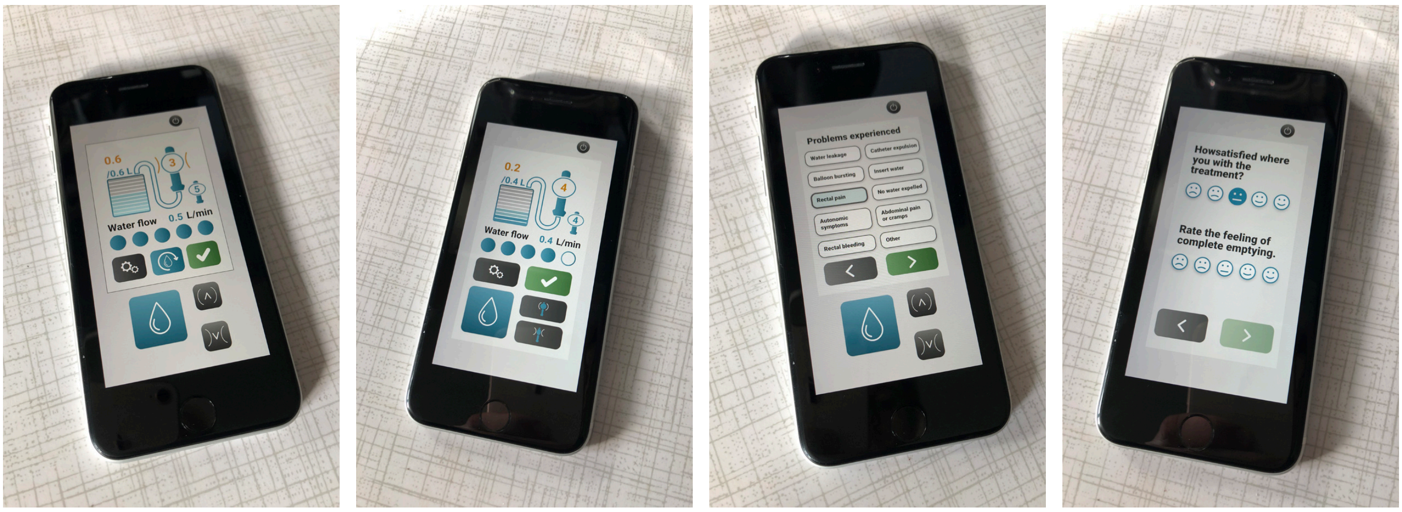


Figure 15: sample of screens from the prototype with three fixed buttons and without fixed buttons presented on the phone which was used in the digital UI prototype.

from the test can be found. The key findings from the digital prototype tests are:

- The interface using a larger screen and the interface using a smaller screen together with three fixed buttons were generally considered equally good, but sometimes the interface with a larger screen was considered slightly better.
- The icons for inflating and deflating on the interface with a large screen were considered easier to interpret and better looking.
- The wording of ”water flow” made it difficult to interpret as the speed of the water.
- Regarding the use of orange as an active color and blue for settings, this was expressed as a liked feature by some and not understood by some.
- The wording in the instructions was difficult to interpret when words were supposed to be matched with icons.
- The users did not experience any difference in size of the buttons in the interfaces even if the interface with a larger screen had a lot of buttons that were larger.
- Having less information and options at the same time was favored by some users which was more the case for the interface with a smaller screen.
- Both interfaces were experienced as having a lot going on at the same time.
- Both interfaces where generally seen as easy to use even if the users had not seen the interface before and did not fully understand how the product was used.
- Finding, understanding and changing the settings were most difficult.
- The buttons to finish treatment and move to reviewing was interpreted as different things and used at the wrong time in many cases.
- Because the interface includes a lot of options and information, users sometimes spent time reading information that was not what they were looking for.

The result from the digital prototype test shows that there is not a lot of difference in the two interfaces and that there are positive and negative aspects with both. The results also show that the interface is easy to interpret but that there are aspects of it that should be changed to make it easier to interpret and faster to act on information. Future tests could, depending on purpose, include more graphics to make it easier for the user to interpret the instructions on what buttons to press.

7. PHYSICAL PROTOTYPE TESTS

In this chapter the testing of the physical prototype is presented. The chapter includes the development of the prototype, the execution of the test and the results from the test. As shown in figure 16, this chapter is one of the first three blocks which are made to gain insights in how the product is and can be used.

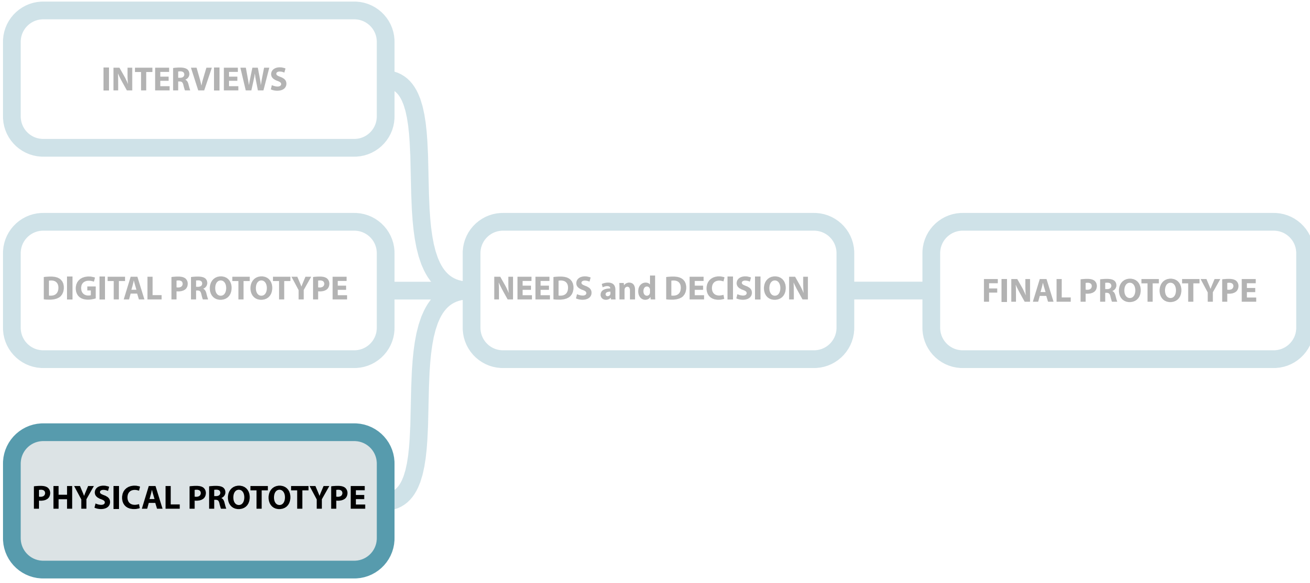


Figure 16 : showing that this chapter is one of the first three blocks in the process of the thesis.

7.1 Physical Prototypes for Testing

These prototypes were made to be able to test the differences between pressing a physical button and pressing a touchscreen while controlling the flow of air and water of the unit. The construction of the physical prototypes was made together with two engineers from Wellspect who has knowledge in electronic components and software engineering. The prototypes differentiate themselves in the kind of buttons but also in that the prototype using the touchscreen has a built-in vibrator to test as a mode of feedback. The two prototypes can be seen in figure 17.

The screens that were chosen for the prototype are resistive touchscreens. This choice was made since there are issues with the current buttons that are capacitive touchscreens, similar to those in phones, which can be affected by water. Resistive touchscreens require harder pressing but should not be affected by water as much. The sizes of the screens were chosen from resistive touchscreens sizes that could be found online and could fit in the hands of most people. The screens chosen are thus:

- 3.2 inches for the version with screen and buttons. The screen size is 4.9 cm wide and 6.5 cm high with 240x320 pixel resolution.

- 4.3 inches for the version with only a screen. The screen size is 5.5 cm wide and 9.4 cm high with 272x480 pixel resolution.

Figure 17: the two physical prototypes, loading and placed on the leg.

7.1.1 3D printed Case

The case for the prototype was custom made to fit the components that needed to be inside each unit. The models were made in Autodesk Fusion 360 and the design of the case focused on fitting everything inside with as small of a case as possible. Prioritizing easy to modify prototype and being able to fit all the components resulted in a boxy shape.

The two cases were made in three iterations each. The first iteration was made as a rough sketch to be easier to communicate with the engineers at Wellspect. The models were then modified to fit the screens better, fit the battery to accommodate for on/off switches, to be able to plug in a USB and to have a tight fit in the case in order for the components not to be loose in the unit. The UI of the 3D modeling tool with a model can be seen in Figure 18.

The slicer (3D printing program) that was used was Ultimaker Cura. The process of making the 3D-model into a printable file was easy since the two prototypes consist of two larger parts. Three additional buttons were printed for the prototype with buttons. The two larger parts are the main case that contained all the details and the back cover that is flat and contains a springing mechanism. Instead of gluing them together the springing mechanism was made in order to be able to open and close it on the back.

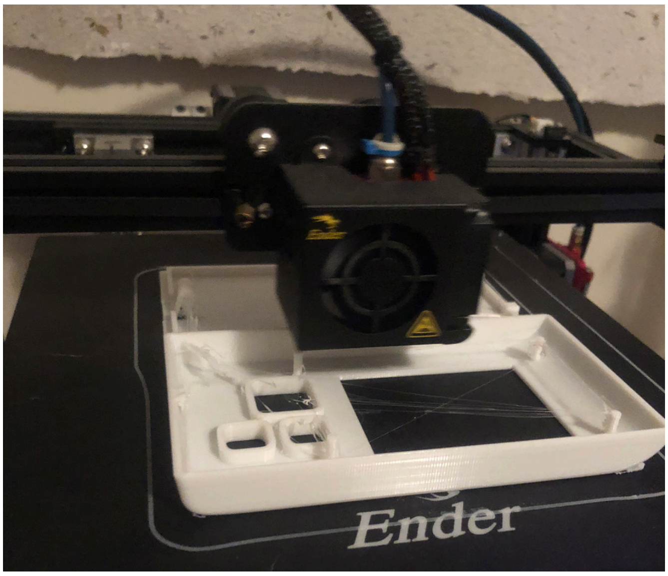


Figure 19: showing how the cases were 3D printed.

The printing was done using a Creality Ender 5. The quality is adequate for doing user testing, but a better-quality printer is recommended for future. work A higher end printer can produce smoother surfaces, especially at curved surfaces and would make the users' experience feel more realistic. Figure 19 shows a picture of the printing of the case.

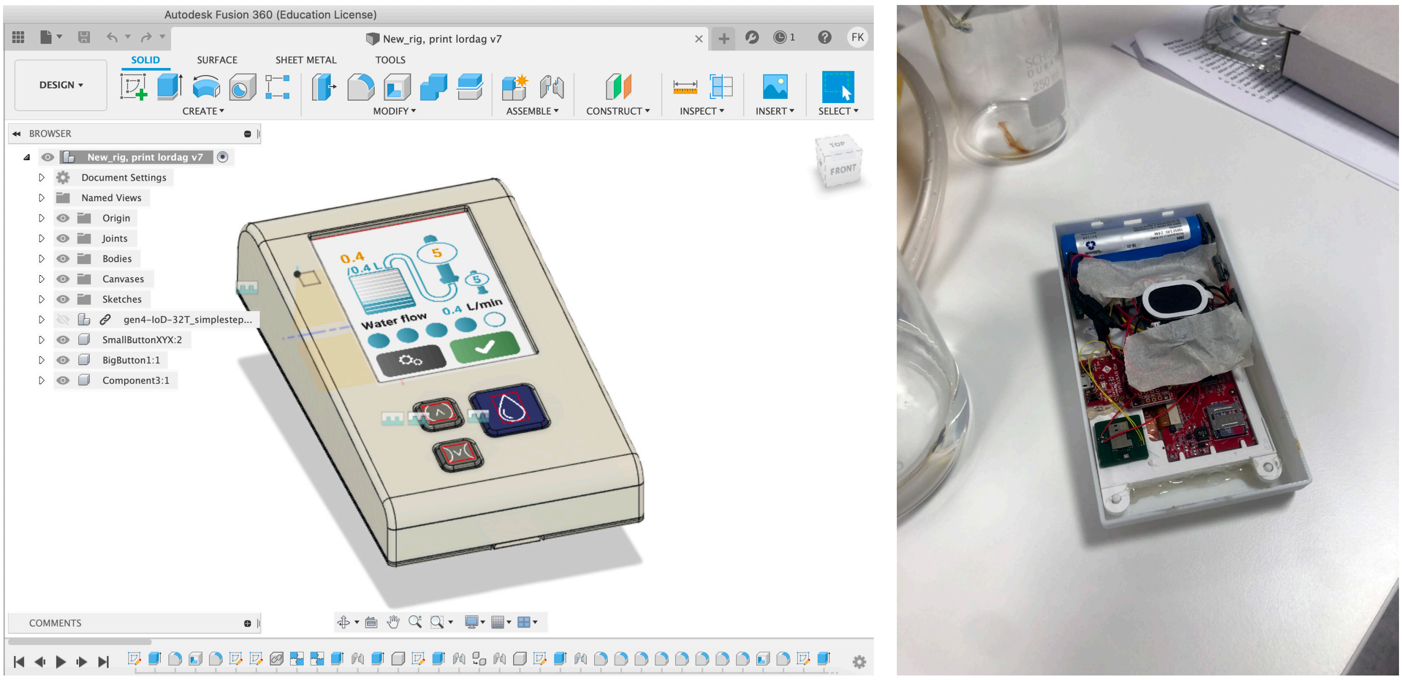


Figure 18: images illustrating how the two physical prototypes was buildt.

7.1.2 Physical Prototype UI

The physical prototype UI is what is shown on the screen of the two prototypes when using it. In figure 20 the screens for the unit with physical buttons is shown and in figure 21 the screens for the unit with a larger screen is shown. For the UI with the larger screen a button is placed for pumping water and buttons for pumping air are placed which is where the user presses.

The digital screens for the UIs are designed in Adobe Illustrator and Adobe XD. They are then exported and sent to a software engineer at Wellspect who put them into the UI. The first screen in figure 20 and 21 are the screen that is shown when the user is going to pump water. The second screen in each figure is when the user is pressing the button for pumping water. The UI then shows water in the tube and water coming from the catheter. The third screen in figure 20 and 21 are the screens that are shown when the user is going to pump air into the balloon. The fourth screen shows when deflating and the fifth screen is shown when inflating. This is to give the user feedback on the screen in order to indicate that it is registering the presses. The user will see the water and air coming through the tube, but this is to create redundancy. The end product is also expected to have on-screen feedback and thus, the choice of investigating the users' experience of it in the test was made.

The UI was kept simple for the physical prototype as there is a lot of work needed for the engineers that build the functionalities for the prototype. Adding functionalities such as measuring balloon size and water amount in the interface would add a lot of hours spent for the engineers to build the prototype and it is not necessary for the test to be performed. The user in the tests is expected to look at the catheter when pressing the buttons and thus the interface does not need to contain a lot of information.

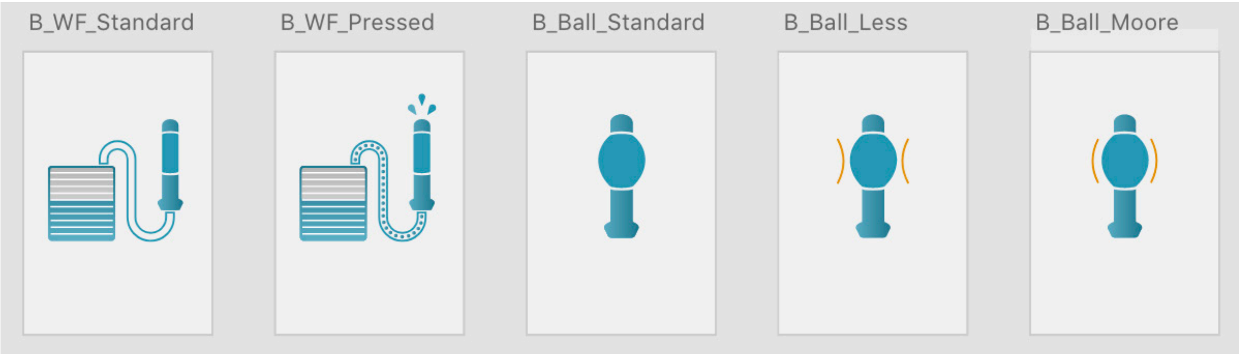


Figure 20: UI for the physical prototype with a screen and physical buttons.

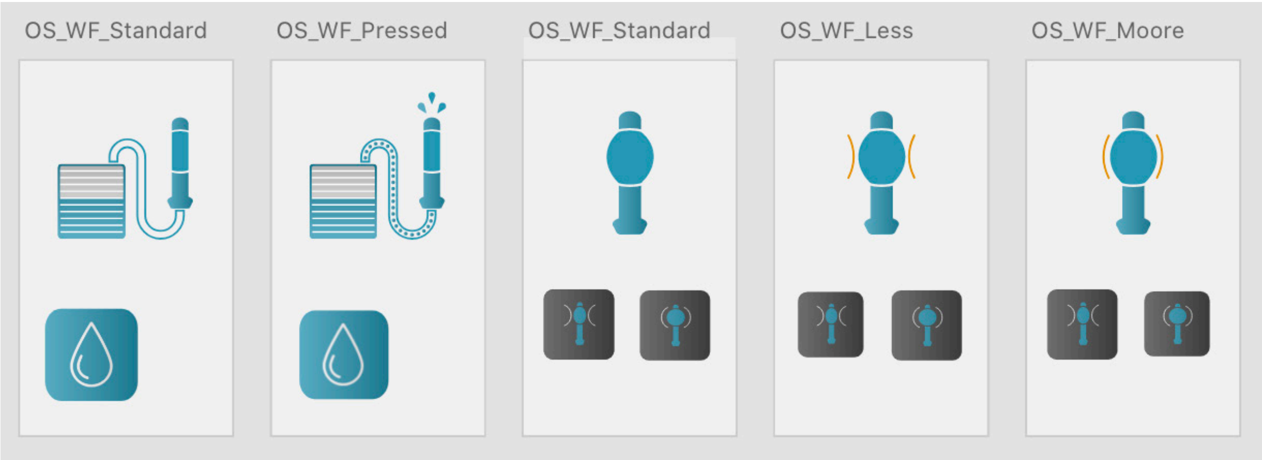


Figure 21: UI for the physical prototype with a larger screen and no physical buttons.

Figure 22: the pump station prototype pumping water and air to the catheter.

7.1.3 Physical Prototype Pumps

To be able to test the physical prototype with the actual actions that it is supposed to do, the two units are connected to water and air pumps. The pumping station is constructed for making this test. The unit consists of a water container, pumps and a tube that is able to pump water and to pump air out and in. This pumping unit that is pumping water and air is solely made by the two engineers from Wellspect. A picture of the pumping unit can be seen in figure 22.

7.2 Physical Prototype Test

The test using a physical prototype was done in order to investigate the tactile perception of using the different prototypes. The test aimed to find out:

1. The difference in feeling of control of the unit.

2. The difference in actual control of the unit.

3. Strengths and weaknesses with both interfaces.

Following is a description on how the test was made and the results of the test.

7.2.1 Physical Prototype Test Execution

There were eleven people performing the user testing. They had little or no knowledge about the product and the interface. When testing the two prototypes the users were given tasks for measuring water and for inflating and deflating a balloon. The users first got to try out the buttons on both prototypes before performing the test, to become more comfortable. The balloon was first inflated to one size, then deflated to another size and then inflated again. The sizes were decided by the Lego figurines seen in figure 23. At each step the test supervisor noted the balloons' closeness to the walls from a distance, indicating if the balloon was very close or not very close to the walls.

After performing the test with inflating and deflating the balloon, the person tested to pump the water with both prototypes. Holding the catheter in one hand and pumping water with the other, the user had to pump water to different increments in a measuring glass. These increments were 20, 40, 60, 80 and 100 ml. At each increment the test supervisor noted how close the water level was to the desired increment on a three point scale which were: ”good”, ”okey” and ”bad”. Good indicates 1ml from the target amount, okey indicates 1 to 5 ml from the target amount and bad indicated more than 5 ml from the target amount. The user tested the units with pumping air and water. For each test the user had the units attached to their leg once and holding it in their hand once. The full description on how the user was to perform the test can be found in Appendix 7.

After performing the tasks with the water and with the air using both prototypes an interview was conducted. The interview questions can be found in Appendix 7. The questions aimed to understand the users’ experience from using both prototypes and what they liked and disliked with the two.

Figure 23: images of the physical prototype test station showing the prototypes, the instructions etc.

7.2.2 Result from Physical Prototype Test

The results from comparing the two kinds of buttons are presented as numeric data from what the users performed at the tests and from what the users said about the experience. The result is also presented as text as the key findings from what they said about their experience.

Statistic results

By noting their results for each button press the data could be compared between the two types of buttons. The testing resulted in 128 data points for the test with air and 214 data points for the test with water, totaling 342 data points. The results were then transformed into percentages to be able to compare and are then presented in figure 25 below. The results show that the users performed better with the physical buttons for both the air and water test. This result is more clearly shown in the test with water as it shows that the ”good” result was 50% for the physical buttons and 33% for the resistive touchscreen. The ”bad” results were 7% for the physical buttons and 14% for the resistive touchscreen. This showed that they either experienced a higher level of control with the physical buttons or that they experienced the same level of control with both types of buttons. The mean value for physical buttons is 8.2/10 and for the resistive touchscreen the mean is 6.8/10.

The results from scoring their performance and from what they express themselves shows that their control of the unit and their feeling of control is higher with the physical buttons in both cases.

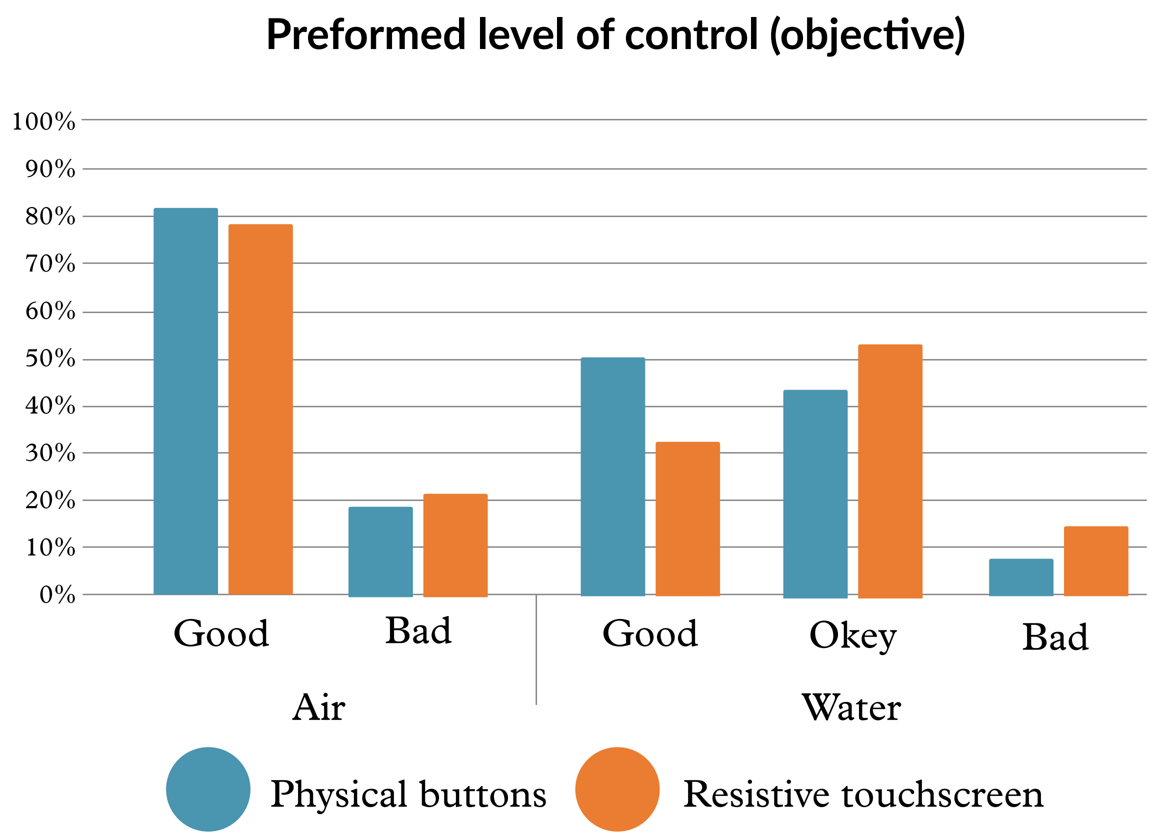


Figure 24: performed level of control.

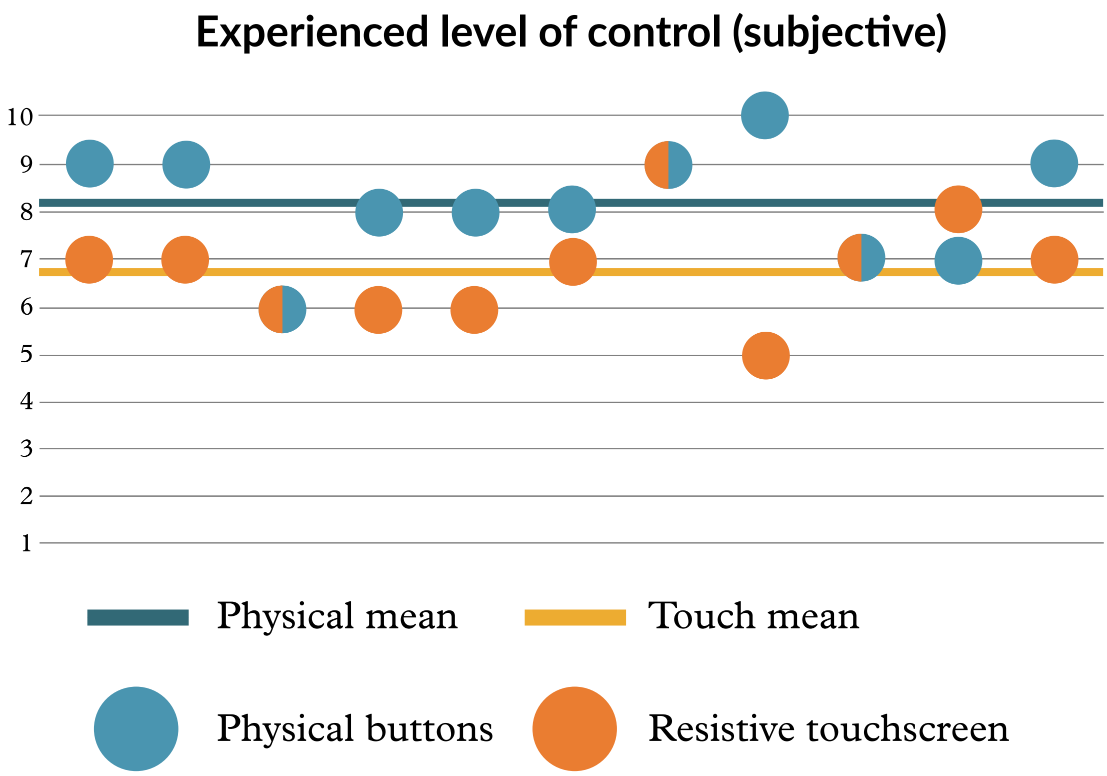


Figure 25: experienced level of control.

Subjective findings
After the tests the test person answered a set of questions and the test person also talked about their experience from using the two types of buttons during the test. This data was collected and analyzed. In Appendix 9 the full transcripts from the test can be found. The key findings from the physical prototype test were:

- The test persons were not used to the resistive touch screens and first treated it as a phone screen which requires less pressure than the resistive touchscreens.
- The test persons generally said that their experienced level of control was higher for the physical buttons than for the resistive touchscreen. This was said both in the scoring of the buttons and during the test with the two options.
- According to the users in the test, the physical buttons gave better feedback.
- Some users expressed that when using the digital buttons, they had to look at the screen. Using the physical buttons did not require this, which made the physical buttons easier to use.
- The touch screen version was experienced as being more advanced and being better looking.
- The vibration feedback from the resistive touch unit did vibrate the whole unit and not only the area that was pressed.

To summarize the results from the physical prototypes; there are both findings which are objective as they reflect the performance on the tests and, subjective as they reflect the experience of the user. The objective and subjective numeric findings both suggest that the unit with physical buttons is better for controlling the unit. The other subjective findings shows that there are advantages and disadvantages with both units, such as that the touch screen version is experienced to be better looking and that the one with physical buttons gives better feedback.

8. USER NEEDS AND PROTOTYPE DECISION

This chapter focuses on the needs of the user and to translate them into requirements and focus areas which are relevant for the result of the thesis. This chapter also conducts a discussion of which concept to choose for further development and why this is the case. The final part of the chapter is a presentation of design guidelines to be used for further development. As shown in figure 26, this part of the process is about collecting the input from the first three parts.

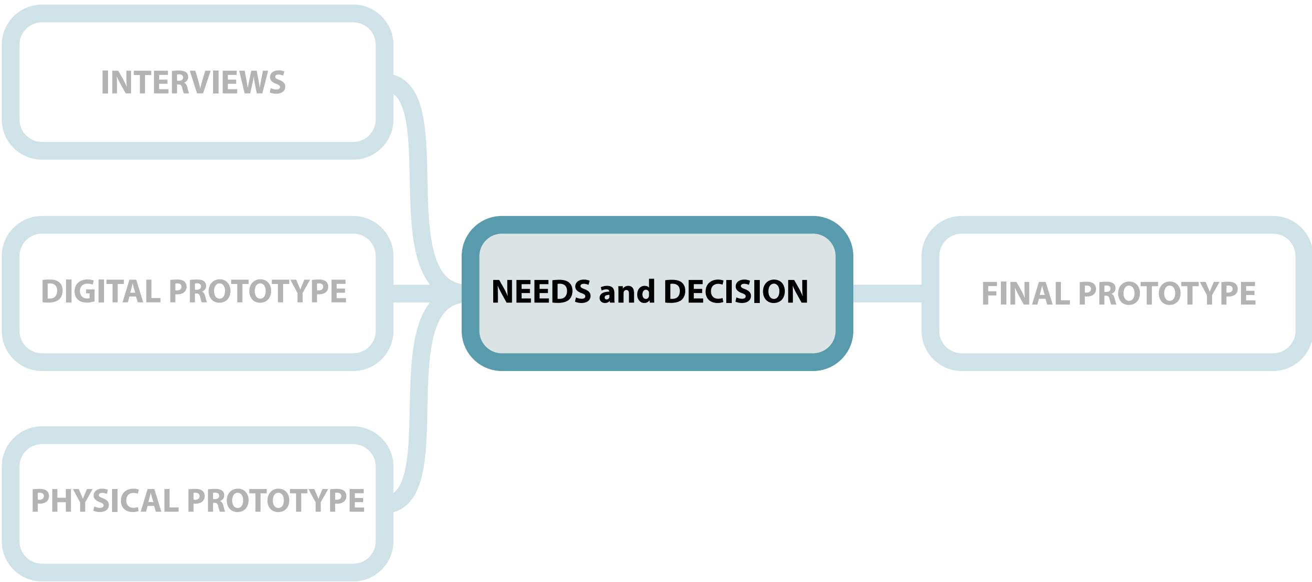


Figure 26: showing that is the User Needs and Prototype Decision part of the process this part of the thesis focuses on. W

8.1 Requirements and Focus

Under this sub-chapter the requirements and areas of focus are presented. The requirements and focus areas are derived from the interviews, user testing and from literature to create guidelines for how the next iteration of the prototype should function.

8.1.1 Requirements

These are the requirements that the product needs to meet.

Legible

Readability is a necessity as the product is also supposed to be used by elderly people who might have sight loss. Legibility is therefore to be prioritized over features that do not serve a larger purpose. If the user cannot read the input the person will not know how to change settings, perform the treatment or to answer the review.

Review

This requirement mainly comes from healthcare professionals which can use the data to improve the health regarding the bowel. If the patient can review the experience easily, it is more likely that the patient will put in the effort of reviewing and by doing so helping themselves and others.

User adaptive

The users are different with a variety of medical needs that should be taken account for. Allowing the user to input settings and interact with the unit in different ways make it possible for users with different needs to use the product in a better way.

Multiple modes of feedback

There are different users, with big variability, such as paralyzed individuals, assistants and users with no other issues than anal incontinence which also can be seen when looking at the personas. Therefore, there is a need for providing multiple modes of feedback. Two examples are visual feedback in terms of water irrigation and numbers increasing, haptic feedback in terms of pushing the button. The feedbacks add to the feeling of inflating the balloon and instilling water. This helps the users which cannot feel the bowel such as paralyzed users and assistants who help a patient to also get feedback that the unit is processing the input.

Show current levels

For the users, this was the most looked at aspect in the interface according to the interviews and it was also the most important aspect of the user testing when testing the digital prototype. Showing the current levels and make them distinguish themselves can make it easier for the users to follow the treatment.

Let the user irrigate multiple times without priming

As many users irrigate more than one time, they need to prime the unit again which is unnecessary. Therefore, the interface should have an option to irrigate again for the unit to keep the pressure in the catheter. This would also improve the data. Now, the data shows two separate treatments, and this would make it into one treatment with multiple irrigations.

8.1.2 Focus Areas

These are the focus areas of the product that the stakeholders express to need extra effort.

Easy to understand
Not being able to understand the unit can cause issues for all stakeholders. The users might experience frustrations from not understanding what to do when handling the product. Other stakeholders such as sales representatives and nurses can benefit from being able to understand the aspect of the product when they themselves have to inform others about it.

Easy to press buttons
The buttons on the screen and especially the treatment buttons should be easy to interact with by pressing. The interviews showed that the users have multiple different issues regarding their hands and the user testing shows that making buttons too small can make them difficult to press. Making buttons which are easy to press for different kinds of needs is therefore important to focus on.

Be a mean to perform a task
Users do not express that the product should be a fun experience, they rather express joy for the product in that it solves an issue. Therefore, they prefer that the treatment is a task that is efficiently done so they can go about doing other things.

Feedback quality
One of the requirements is to have multiple modes of feedback but as literature regarding feedback says, it also need to be quality in the feedback. Zaman et al. (2010) says that it is easier to learn qualitative tactile feedback and that the performance increases more rapidly. Brewster et al (2007) express that there are less errors when the feedback has higher quality. Preece and Rogers (2002) have a principle about feedback which says that there should be an appropriate reaction to show that something happened in order to know that an action has been done. This was also true in the users' studies which showed that when the users felt more in control they also performed better. The feedback which can be focused on is both the visual and the haptic. The haptic feedback of the pressing on the unit can be looked over. The visual feedback on the screen should be clear for the user for them to understand the message.

Differentiate items in the UI
In order for the user to be able to distinguish items from each other in the UI they should try to differentiate themselves from each other. As this UI includes more items on the screen then the current Navina Smart, the UI should inform the user of how the different items work. Literature regarding medical technology and usage of gestalt principles also suggests separating things into groups by similarity and proximity, by doing that they are easier to understand. In the digital prototype test some users had issues with what items belonged together. Examples of this are that they thought the finish button were associated with the settings button.

Informative
The interface should, in an adequate way, give information about what the icons, buttons and numbers in the interface do. This is the case both for the feedback of each action and for the overall picture. The icons, buttons and numbers in the interface should be able to be understood.

Allow learning
According to the interviews with users, the nurse and the sales representatives, the experienced users do not seem to have issues other than warning messages while novice users can have issues with usability and understand what the steps in the treatment mean. Allowing the user to learn, by providing material and giving feedback, the user can improve their understanding about the unit to become an experienced user as mentioned in chapter 2 about the SRK-model. By providing information and cues, the user can go from being knowledge-based to rule-based and for some instances skill-based in using the product.

8.2 Concept decision

The concept decision is based on literature, interviews with users and tests with physical and digital prototypes to gain understanding of what is preferred for the product. The concepts are also put into relation to the personas to try to think of what concept would fit them the best. Following is a discussion based on these factors. Then a comparison of the two concepts is done and a decision of which concept to move forward with is presented.

Comparing the concepts to the user requirements list do not give much insight to the decision as the two concepts are similar in function and much can be done to live up to these requirements.

Comparing the two concepts based on the results from the user testing of the physical and the digital prototype indicates that there are positives and negatives with both as expected. The results from the physical user tests indicates that the users both have better control over and experience that they have better control over the prototype with the physical buttons. Based on the data of the experienced control a 1.4 point on a 10 points grade scale difference was seen on average (6.8 for touchscreen and 8.2 for physical buttons). All the responders either thought the control was the same or that the physical buttons were better. This was also expressed verbally where a lot of testers strongly disliked the touchscreen and expressed joy when using the physical buttons for the tasks.

The aspect of being able to divide the attention of multiple things when doing a task was both brought up by the users in the user testing and by Nagarajan et al. (2020) as something that is easier when adequate feedback is given to the user. According to some testers in the physical user test it was nice to not have to look at the screen as much which is shown by the user test to be more needed when using a touchscreen. The assistant persona who helps a patient would need to both press the buttons, keep an eye on the UI and the patient. Thus, feedback which indicates that the buttons are pressed without having to look would make it easier for the assistant. A user who is using the product on himself/herself could also benefit from receiving more feedback from buttons if the user needs to hold something else with another hand, such as the catheter.

The potential for the concept with physical buttons to press with a larger part of the hand for irrigation, and pumping the balloon is also an argument for it to be chosen. This aspect of the concept can also be explored in the future. The concept with a touchscreen uses a resistive touchscreen which makes it need some force to press, but the extent of this is not known and could be explored in future testing.

In conclusion regarding the concept decision, based on that there is not a lot of factors arguing for the larger screen other than the esthetics, the potential for more variations and larger moveable buttons it is not the chosen concept. These positives are not seen to be a need for the user based on the interviews and the user tests. Users and other stakeholders instead express that they only want everything to work and then go along with their day. Literature emphasizes error minimizing and giving feedback. As this product is used as a means to perform a task rather than a product to explore, the concept with physical buttons is a better fit for the users.

Choosing the unit with three fixed buttons also made a trade-off in the three levels Norman (2004) describes in relation to the unit with a larger touch screen. The full touch screen model was said to be better looking and a high-tech product which could improve the self-image of the user, if the user care about technology. This type of reflective pleasure is although not priorities. In this case the behavior level was priorities as the unit is mostly said, in the interviews, to fill a function of doing a task. Thus, the pleasure of effectiveness was seen as more beneficial for the user.

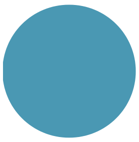
The physical button concept is experienced to give the user more experienced control and the test persons performed better with the physical buttons. The users in the digital prototyping test also likes aspects of the unit with physical buttons such as having less information on the screen and a clear distinction between the screen and the most used buttons. Many of the likes of the touch screen version can be translated to the version with physical buttons such as symbols and wordings that were tested with that unit. What is more difficult to achieve is the sense of high-end technology which a touchscreen perceives more than physical buttons, but this is also seen as both a negative and a positive as user might like having high end products but also being scared of it looking more technological.

8.3 Design guidelines

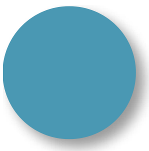
To get a coherent interface some guidelines were created. The coherence creates order by having similar functionality for the same type of color and shapes. The user can thus learn what a color means and distinguish what they are searching for while using the product. The idea of creating coherence in the interface this way comes from the gestalt principle of similarity. The principle says that the users attribute similar attributes to things with the same properties. Other gestalt principles are also used in the interfaces, but these are not a part of the guidelines, as they are adapted where they fit in each case. Every shape and aspect of the interface is not explained but the color and shapes meaning gives an understanding of the bigger picture.

8.3.1 Color and Meaning

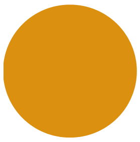
The interface uses multiple colors to be able to distinguish different attributes from each other. Following is a description for what is attributed to each color. Some colors carry multiple attributes as they can be a signifier for something and an interactive button at the same time. Here is the list of the colors that are going to be used in the interface and what they are used for:



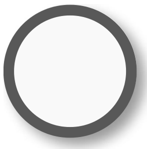
Blue without a shadow is used as a color that can be changed depending on the setting and other actions and is thus a color which is changing with interacting. Balloon size, water amount and numbered settings use blue to show that they can be modified. The water flowing through the tube and coming out of the catheter also use blue as it represents water.



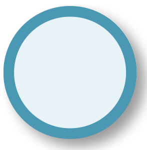
Blue with a shadow is used when the blue color is interactive. Blue interactive buttons either are used to change a setting for the treatment such as changing water speed, balloon size or to navigate to or from the treatment such as starting the treatment. Blue is used here instead of green as these buttons are large and the blue color then can connect more to the brands logo which is blue.



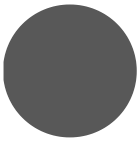
Orange is used for the most important numbers in the treatment mode which are the balloon size and water amount irrigated. It is also used to give feedback about that the balloon is increasing or decreasing in size. It is thus considered the most ”active” color. The orange color contrasts the blue as they are opposite in the color circle. This together with the sparse use of orange makes it pop out which is beneficial for the user as they easier can find the important numbers which they use to track their progress in the treatment. It could be argued that the water coming from the tube and out from the catheter in the UI should be orange as it is the same kind of feedback as the feedback about the increasing and decreasing of the balloon. However, to be able to more easily focus on the orange numbers and not have too much orange in the UI at once blue was chosen instead.



Dark gray border with a light gray fill is used for interactive buttons which contain information such as text or icons. They are used for different purposes depending on the stage of the treatment. They are firstly used as less prominent buttons as they have no color and thus blend in better. These buttons are used less and should only be looked at when needing them and they should not require much attention. This is therefore used for the information button and the settings button. It is also used as an interactive button containing text which can be activated, this is the case in the review screen when this button changes to another color when pressed.

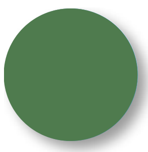


Blue border and a light blue inner is used when the button has been pressed to give feedback that it is pressed. This is used in the review stage where text boxes are selected and the shape makes it possible to differentiate the selected boxes to know that it is selected. The light blue inner makes it easy to distinguish from the unpressed buttons while still giving contrast to the text inside the shape.

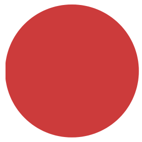


Dark gray is used informatively to create fixed shapes in the interface such as the shape of the catheter, by doing so the water tube and water container gives a framing of what the other aspects do. These shapes will not change depending on interaction or settings. This color is also used for the up and down / inflate and deflate buttons on the physical buttons as it gives contrast to the icons in the button and differentiates themselves from the blue water button. Black was not chosen as it becomes too dominant in the UI, and in this case the dark gray shapes are only there to assist the other colors to give them more meaning.

Light gray is used to represent the absence of something to inform the user that there is space to fill if s/he wishes. This is used in settings to show how much water can be used from the tank, to indicate the water speed and to show that a certain amount of water has been irrigated.



Green is used where other colors are also used to differentiate itself to show where the button for proceeding is. If no other color is used, blue is used as the proceeding color as it is the main color of the interface.

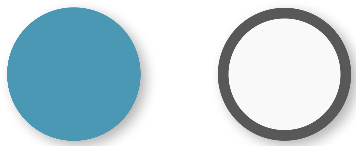


Red is used to warn the user about something and is used sparsely in the interface. It is only used to indicate when the battery is low and to show if there is a waring of some kind. Red also differentiate itself from the rest of the UI and the warning can therefore be noticed easier.

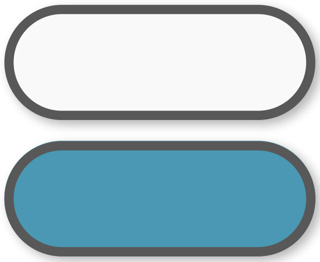
For the background a light gray is chosen as it has the potential to give a lot of contrast to the other parts of the UI. At the same time, it lets white parts of the UI such as inside the water container, the water tubing and inside some buttons, differentiate itself from the background.

8.3.2 Shapes and Meaning

In the interface there are mainly three shapes which appear multiple times and they are all quite similar. Other than that, there are shapes that only appear one or a few times such as the catheter and the water tubing which are there to convey an informative meaning with their shape.

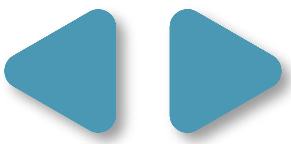


Circles and circles with shadows are used as smaller buttons, either as a row of buttons to change setting or with an icon to give a meaning and perform an action. Circles are mostly used when the purpose of the button does not need more explication and to not take up too much space in the UI. Circles are used for information buttons and the settings with an icon to indicate what it does. Circles are also used to change water speed as a row of circles but without an icon and instead relying on the text close to it to give the circles meaning.



Rectangle with rounded sides can be used as buttons containing text. The buttons can either be used as buttons to take the user to another screen or to be pressed and then give feedback that it has been pressed. These are for example used as the finish button to indicate that the the user is done with the treatment and in the review when they can be pressed and then change appearance. It is also used in the review to indicate that they have been pressed. They can either be filled or not depending on what color is appropriate for the purpose.

Large, rounded rectangles are used to contain information and they are used in order to be able to contain a lot. These are used for information boxes when they show the information and for warning information.



Triangles are used as buttons. They symbolize arrows where up and to the right are used to indicate more and down and to the left to indicate less. These are used either to change settings or to inflate and deflate. They can be used together with an icon to get redundancy in information.

8.3.3 Roundness

The literature in chapter 3 points out that round require less mental processing and makes for a calmer experience. As this product is a medical device which has no reason to provide emotions else than calmness and effectiveness an effort to round the parts of the interface should be made.

8.3.4 Text Size

From doing prototypes and gaining insights from literature in chapter 3, a size 22pt is recommended for most text. To differentiate other text from the smaller text using 22pt it can either be a larger size or distinguish itself in another way. Longer informative text could use smaller text, i.e., in the information and warding windows, as it is otherwise difficult to fit the text on the screen. Larger numbers can be used to distinguish themselves from the rest of the UI as they are the most looked at in the UI.

Text should have high contrast to the background to be able to read it efficiently without strain and thus it should either be a dark text with light color background or light text with darker background. For smaller text, black text with white background is preferred as it is easier to read as both the Office of Disease Prevention and Health Promotion (2016) and Lidwell et al. (2010) says it is preferred. They also say to use sans serif fonts for easiest legibility on screens and thus it is what is going to be used.

This is an example of using text size 24pt with capital letters and size 22pt for Roboto bold. It also shows size 24pt and 35pt for numbers:

8.3.5 Button Size

As the product is used by a variety of people, from having with fully functioning hands to having different function variation it is important to take as many as possible into consideration. Making the buttons large will make it easier to press on the screen but can give buttons to much space on the screen which could make it cluttered.

According to literature and companies designing UI which is used by millions of people, a range of minimum size of a perusable area are from 8.9 to 20 mm. Smallest distance of 8.9 - 9.8 mm for phones are recommended by Apple and Google (Material Design), 11.43 for older adults and 16.51-20 mm at the smallest distance for high performance. As this product is not considered a high-performance product and there are not many presses on the screen needed to perform the whole treatment and the speed of the presses is not required to be high a

22pt **Water Speed** **Pain & Cramps**

24pt **SETTINGS** **FINISH** **ISSUE**

24pt **3** **0** **0.6** 35pt **5** **0** **0.4**

Figure 27 Text sizes for the interface.

size smaller than 16.51 can therefore be used. The 11.43 mm as a minimum is tested in a high-pressure environment with fast paced pressing and accuracy testing. As the screen is not very large a minimum size of press able area of 10 x 10 mm is therefore thought of as an adequate size for the buttons in the UI which require single time pressing.

It is also important to differentiate button size (actual press able area) and the size of the item which is being pressed. By having a larger pressing area than the button, it is easier to design an UI which is not as cluttered with large items while still having space to press.

As it is the prototype with physical buttons which is chosen, people with more difficulties using their hand can press the physical buttons with large parts of their hands without disturbing other aspect of the UI as they are not touch sensitive. If the user only wishes to use the physical buttons it is possible. The user can: turn on the unit with the physical button, press the water button to choose start treatment, prime with the water button, inflate with inflate button, irrigate with water button, deflate with deflate button and then finally turn off the unit with the on/off button at the top. If the user uses more than one irrigation, they w need to press the screen two times for each additional irrigation (pressing the finish button at the top of the treatment screen and the irrigate again button). These two buttons are larger buttons with adequate space from other interactive buttons. This is the case when the user has his/her preferred settings and do not wish to change them which is common for most users after getting used to doing it their way. Further development could also make it possible to go through every step of the treatment without using the touch screen at all, including settings and reviewing by only using the physical buttons. This would require more development and further user testing but is seen as a possibility which might be appropriate for part of the users.

8.4 Needs and Decision Summary

The requirements and focus areas which are derived from the first three blocks and literature creates the basis for the decision of which prototype to choose and how to iterate the next version.
The requirements and focus areas target how to make it possible for the user to understand the product and have a pleasant time using the product by describing aspects of use taken from the tests, literature, the users and other stakeholders.

The decision for what concept to continue with fell to the unit with physical buttons. This was mainly due to the higher rate of experienced and performed control in the user tests, the different ways it is possible to interact with it and that the experienced pros with the unit with buttons are more functional that the unit with a larger screen. The pros regarded to the unit with a larger screen are more focused on esthetics. Some of the aspect which were considered positives for the unit without physical buttons is also possible to mimic by the digital version, such as icons.

The created guidelines focus on giving the user a better understanding of the interface by taking from literature to give the interface attributes which are easier to understand, colors which match their meaning, sizes which are appropriate for this kind of product and coherence for the objects in the interface.

9. FINAL PROTOTYPE

In this chapter the final prototype is presented. This is done by presenting the flow of the interface, each screen with their components, renderings of the UI with the physical buttons, the UI shown on a phone to show how this can be tested for the next iteration and a description of the physical prototype. As shown in figure 28, this is the last part of the process and it is based on the four previous parts which includes interview insights, personas, prototype insights, requirements, focus areas and design guidelines.

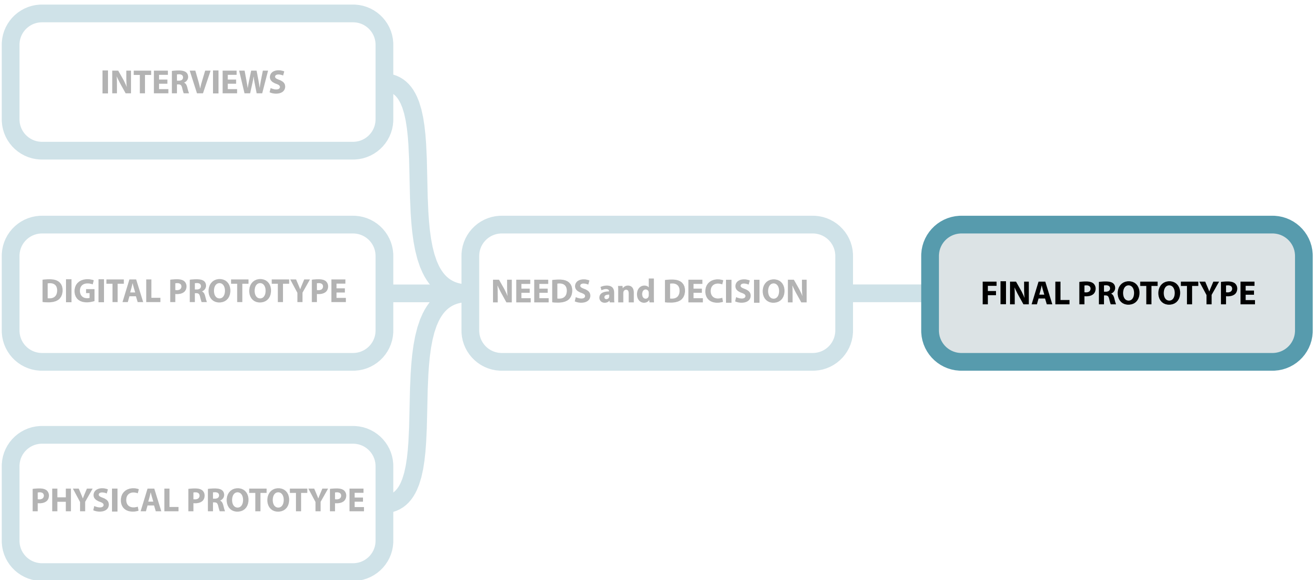


Figure 28: showing that is the Final Prototype part of the process this part of the thesis focuses on.

9.1 Use Flow of UI

Because the treatment needs to follow certain steps and that the review needs to come last the structure of the stages are set. From the base structure of the treatment the user can choose to go into setting up until being finished with the treatment and select info-buttons related to each screen to gain understanding of what they mean. The flow of the UI disregarding going to settings and pressing the info-buttons is as follows:

1. Selecting start treatment in the startup screen.
2. Priming the unit by using the water button and then proceed to treatment by pressing the screen or the inflate button.
3. Performing treatment by inflating the balloon, irrigating water and then deflating the balloon.
4. Selecting if the user wishes to irrigate again and thus go back to a resented treatment screen or to review the treatment.
5. Review the treatment by answering questions.
6. Turning the unit off.

The steps of the UI is visualized in figure 29.

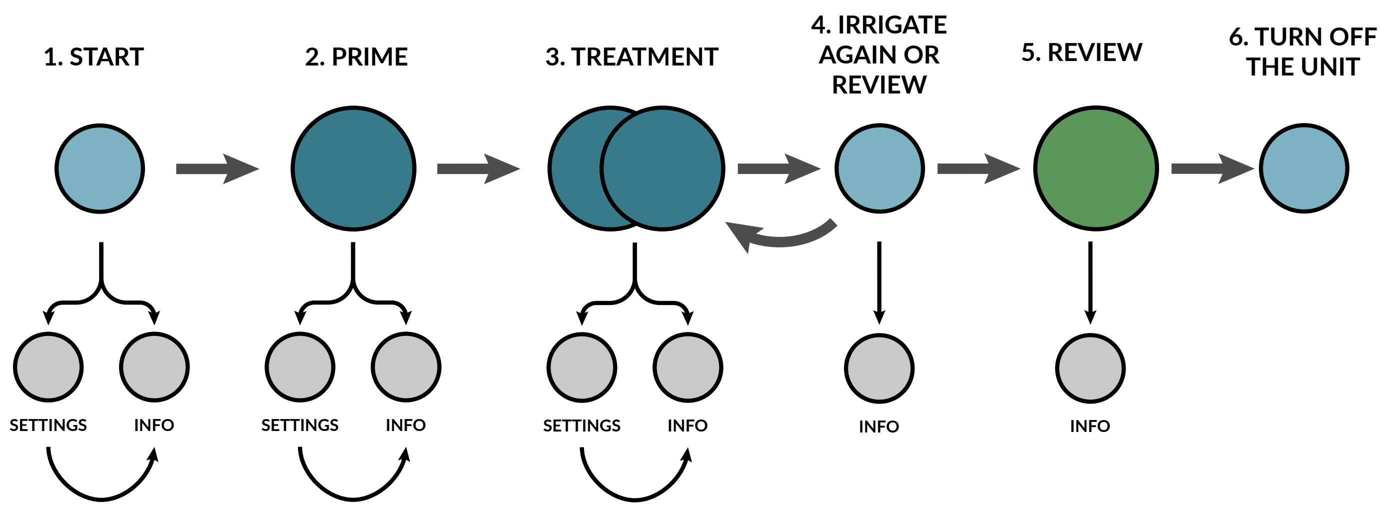


Figure 29: the steps of the UI when doing the treatment.

9.2 Button Layout

As the concept with three physical buttons were chosen the buttons were also given more thought. The previous symbols from the physical prototype were replaced with the symbols used for the digital prototype as they were expressed to be better understood and liked. The shapes of the buttons were also redesigned to have a large circular button for irrigating water and two triangular buttons for inflating and deflating the balloon. Having one large circular button and two smaller triangular buttons is to give the two kinds of buttons differences and thus create a similarity gestalt for the two triangular buttons and differentiate them from the larger blue button. By placing the arrow buttons closer together, it also creates a closeness gestalt to show that they in some way belong together. In figure 30 the full interface is shown and the buttons by themselves.

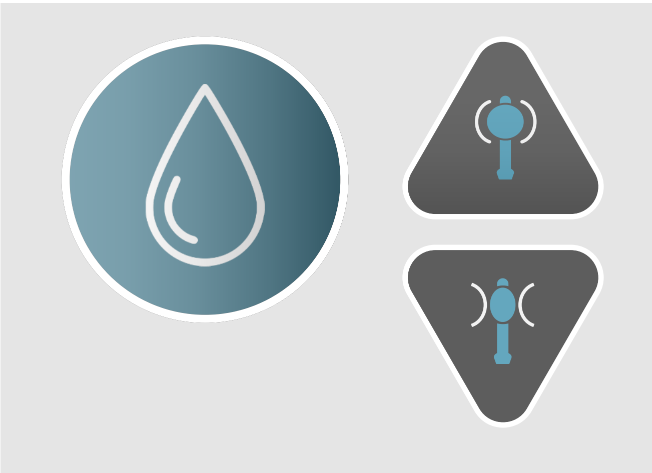


Figure 30: shows the physical button placement.

9.3 Digital Interface

The Digital interface is presented on the unit's screen and with the buttons on the screen and the physical buttons, the user is able to perform the treatment. The UI was in this case also made in Adobe Illustrator and Adobe XD to deliver a prototype which is able to be tested for further iteration. Size of the buttons is important as some users have varied functionality in their hands and larger buttons make it easier to press. Each button on the display has at least a pushable area of 104 mm^2 and a minimum smallest distance of perusable area of 10.2 mm. A visual representation of this can be seen in appendix 10. Buttons used in every treatment which do not concern info or settings are larger. Other than providing buttons to interact with the UI also provides the user about information regarding their treatment and how the settings are currently set. This is done by providing illustrative feedback and numeric feedback to the user. The illustrative feedback is used to aid the numeric feedback and making it more redundant and descriptive. This is described further in each step of the treatment. Following is a description of each stage in the treatment and images to accompany the descriptions.

9.3.1 Start screen

The left screen is how the unit looks while turned off and by pressing the on/off button at the top of the screen it is turned on showing the right screen. This screen presents the user with the name of the product, the current battery level and three buttons to press. The top left button is an information button which can be found on most places in the UI and when pressed presents information about the current screen. This is for the user to be able to learn about each stage of the treatment to understand what to do and why. The bottom button spelling "SETTINGS" brings the user to the settings part of the UI. This button is placed here as the first thing the user does when receiving a new unit is to select the settings which are determined together with the healthcare professionals. This button is also

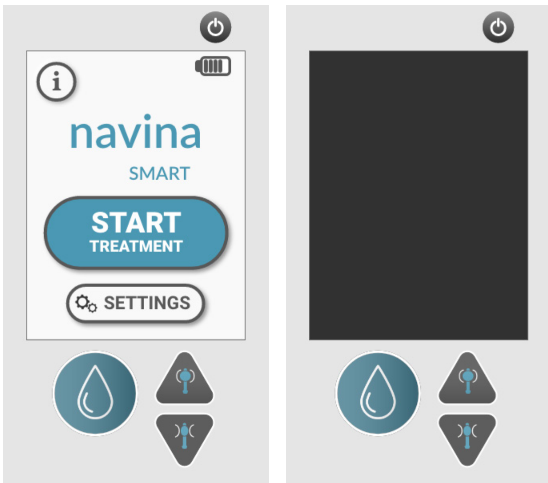


Figure 31: the prototype showing when it is off and the start screen.

placed here to connect the word ”settings” to the symbol as the symbol is what is used for reaching settings in the rest of the UI. The large blue button with the text ”START TREATMENT” brings the user to the priming stage of the treatment which predeceases the treatment stage. This button is used every time a treatment is performed and is probably the only button being used for more experienced users who do not have to change settings or read any information.

It is possible to have the blue water button to also make the user start the treatment as it is placed better for the user to press and they share the color to provide for some gestalt in terms of similarity. This is something that can be further investigated in future iterations.

9.3.2 Priming

This is the stage the user comes to after the start screen. This is a between stage which gets the unit and the catheter ready to start the treatment. To prime the unit the user presses the blue water button to start irrigating, as described on the screen. The UI then shows that water is flowing in the tube and an animation of water coming from the catheter to give the user feedback that something is happening. When the unit senses that enough water has passed through the tube and that there is no water left in the water tube it notifies the user in the UI by changing the text and the button to press. When displaying this message, the user can press the inflate button as indicated to go to the treatment stage. If the user for instance wants to have more water for the catheter to be slippery the user can continue to press the water button to instill water.

This screen does not use the same shapes and colors for all aspects of the water container, catheter and tube as in the treatment stage. This is partly to be in line with the design guidelines and to just be different as it makes it easier when communicating with Wellspect- and healthcare personal to communicate what stage the user is at. The catheter and the container are all dark gray in this stage as the setting for them is not important when priming. This is also suggested by the design guidelines which says that dark gray should be used for illustrations which will not change. Focusing on settings would distract the user in this stage which goal is to move the user to the next stage. The catheter in this stage is pointing downwards as is suggested to do for the real catheter in this stage when placed in the packaging. The tank is placed in the same spot as in the next stage which is to illustrate that nothing needs to be changed to the water container in terms of placement in real life.

The priming screen also provides an information button to receive information regarding the priming stage and why it is performed and a settings button to change settings here if preferred.

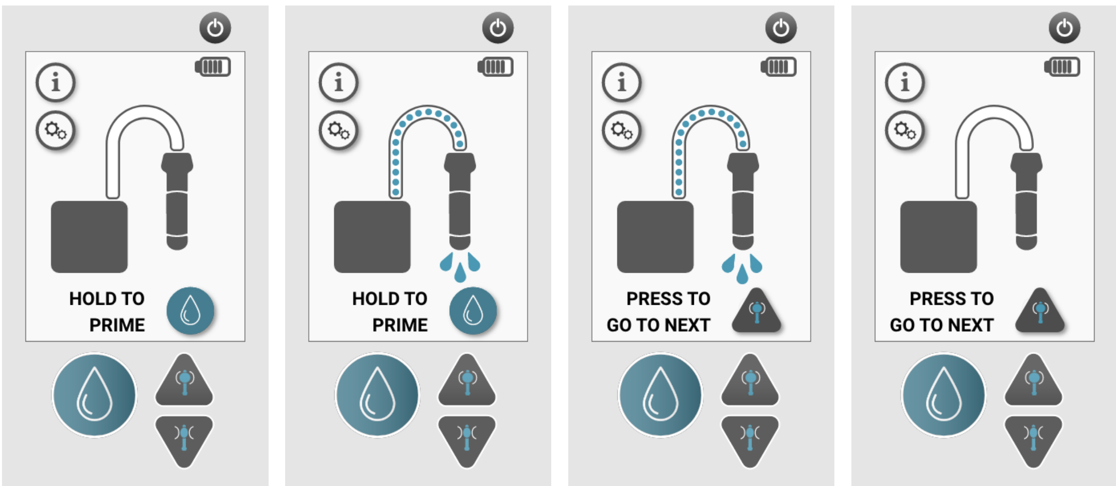


Figure 32: the prototype showing screens from the priming stage.

9.3.3 Settings

The settings menu can be reached from the start screen, the priming screen and the treatment screen. As the treatment is done after those stages it is not necessary to have a button to change settings after that. If happens that the user would like to change settings after the treatment s/he would have to turn on the unit and then change settings and then turn it off again.

In the first settings screen, which is illustrated in the first three images in figure 33, the user can choose to change the maximum water amount, change the maximum balloon size and go to ”functionalities” which provides the user with more settings. The two first groups with water amount and balloon size take advantage of the proximity gestalt principle as the features in each group are closer to each other than to other things. The water amount settings has a title which says ”Water amount” to tell the user what it is and three other main features. The first one is the bar right under the title which displays how much the setting is set to and how much more is the maximum. This bar follows the user to the treatment screen where the blur maximum level is shown similarly to the bar in the settings screen. The bar is transformed by turning it 90 degrees and with other proportions to better mimic a real water container. This is to help the user to understand how the settings affect the treatment. The other features for the water amount setting is the text which indicates the water amount numerically and the + and - signed which is used to change the maximum water amount. The numeric value is there to be able to know how much it is in real volume and this metric follow the user to the treatment screen. The increase and decrease buttons for water amount uses redundancy in both having the + and - symbols and the triangular arrows. This is also to show similarity to the inflate and deflate buttons of the physical buttons. If the user reaches the minimum and maximum amount of water for the setting the button turned light gray to signal that it is not able to be pressed anymore.

The balloon size setting has a header which reads ”Balloon size” to indicate what it is, a numeric value for the balloon size which goes from 1 to 5, a illustration of the balloon and the catheter and controls to increase or decrease the size. The controls are designed in the same way as for the water amount and thus uses the similarity gestalt which indicates that similar things have similar function. Blue is used for the balloon of the catheter to show that it a aspect which can change. The blue balloon increases size as the numbers increases to show that increased number means a larger balloon. The catheter with the balloon and number follows the user to the treatment screen in the same size as in the settings screen.

If the user presses the blue ”FUNCTIONALITIES” button the user is taken to the functionalities screen shown in the two right pictures in figure ASD. At

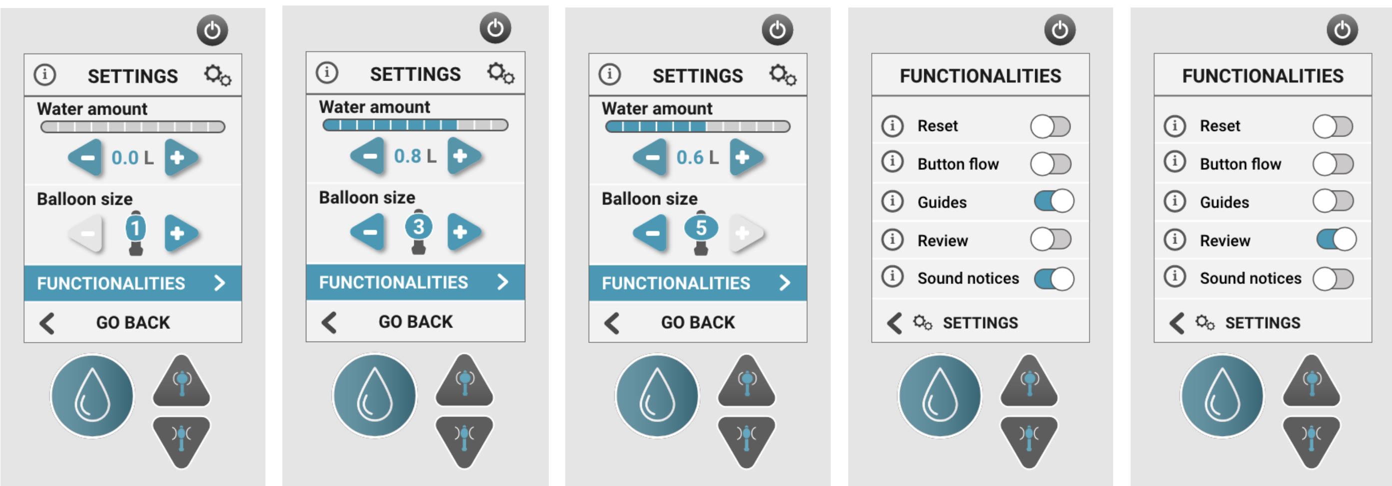


Figure 33: the prototype showing screens from settings.

this stage the user can make changes to the UI to fit their needs. A short description of the functionalities that can be added to the unit is:

Reset
In the interview some users expressed a need to be able to reset the water level as they used water from the unit for other things and thus wanted to reset it to then follow the water amount from zero. This could potentially corrupt the data as users might use this instead of finishing before doing another irrigation. Adding one more button to the UI in the treatment stage would potentially also make the screen messy.

Button flow
This is a feature to make it easier for the user to only use the physical buttons. By activating ”Button Flow”, the interface shows the physical button icons in the interface to indicate what to press to move around. This function can be useful for some users who wish to not use a touchscreen at all.

Guides
Guides is the same as the information boxes that appear when pressing the info button at each stage, but they appear automatically.

Review
The review functionality is on as default but to not force the review on the users they can opt out of making the review. Some users may not want to bother with reviewing their experience and users who are used to not have to review their experience from the previous unit might not want the extra task to do. Hopefully the review stage is designed well enough for them to not be discouraged to continue to review their experience and not opt out of it.

Sound
This feature is not explored more than that it is seen as an opportunity which might be beneficial to some users and which will not need a lot of development. Providing sound to the UI adds feedback to the user which s/he can either use as additional feedback or use instead of visual feedback. Sound could be used to indicate that the water is flowing, or the balloon is inflating/deflating. It could also be used to indicate how much water has been irrigated and if the user is closing in the maximum set value.

For each functionality that can be activated there is an information button and a activation button. The information button provides the user with information regarding that functionality and what it means to activate it. The activation button is designed to show when it is active and not by sliding from left (not active) to right (active). Light gray is used to represent not active as it is otherwise used to show that something cannot be used or that the area is able to be filled. Blue is used for the active color as it is used for setting throughout the interface.

9.3.4 Treatment
This stage in the process of using the product can be considered the main stage. The previous stages are either to prepare for this stage or to choose the correct setting for this stage. The stages after this are to review how this stage went.

In this stage the user starts with inserting the catheter. When the catheter is inserted, the user inflates the balloon to keep it in place using the inflate button. Then the user instills the bowel with water using the water button. When instilled to the desired amount the user waits a while with the water in the bowel and then deflates the balloon using the deflate button and removed the catheter.

In the treatment stage there are multiple buttons which can be used and information’s to be perceived. There are two small buttons at the top left which are the information button and the setting button. The information button can be pressed to show information’s regarding the performing the treatment and the settings button bring the user to the settings page. The buttons are placed at the top as they are used more rarely than the other buttons and probably not at all when the user has become experienced in using the product.

The finish button at the top is green to differentiate itself from the other buttons to indicate that it does not have to do anything with the ongoing treatment. Using a symbol was tested in the user testing, but it was easy to interpret wrong and thus a text message showing what it is doing (finishing the treatment) is potentially easier to interpret correctly. The finish button is also placed furthest away, at the top of the unit, to spare itself from the buttons which are used more often and as the finish button is only used to finish the treatment it does not need to be as easy to reach fast as some other buttons which are used during the treatment.

The catheter is illustrated in the treatment stage to help the user to understand the water irrigation animations and the balloon inflation animation by showing that is from the catheter the water is coming and that it is the balloon on the catheter which is inflated. In contrast to the priming stage the catheter is pointing upwards as it does in reality when inserted. The contrast is also good to be able to differentiate the two stages. Dark gray is chosen as colors as the catheter itself is not changed in any way, only things around it.

The water container is showing the level of water which the treatment is set to and how much have been used out of that water. From the water container to the catheter there is a water tube which shows that there is water flowing in the tube. As compared to the current Navina Smart unit, the tube is made wider to easier be able to see if there is something inside. The tube is made dark gray as it is not changed in any way and to differentiate itself from the blue water inside of the tube.

If the user does not need to change anything or look at the information, the user only has to use the green finish button at the top to finish the treatment and the physical buttons to perform the treatment. Following is a description of each of the three steps which is performed when doing the treatment.

Inflating

The first step in the treatment is to inflate the balloon to the desired size from 1-5 by pressing the inflate button. Starting out the balloon shows an orange 0 inside the balloon catheter to indicate that the balloon is empty. Down to the right the uses can see the maximum size which the balloon is set to, in figure 34, image 1 it is set to 1 and in image 2-5 it is set to 5. This is set in the setting stage. When the inflate button is pressed, there are orange indicators which gives the user feedback that there is something happening to the balloon which can be seen around the balloon in image 3-5 in figure 34. When the balloon reaches the level of each size it changes the number inside the balloon and the shape of the balloon is changes to compliment the size. The number inside the balloon is made larger and orange as it one of the most looked at aspect in the interface.

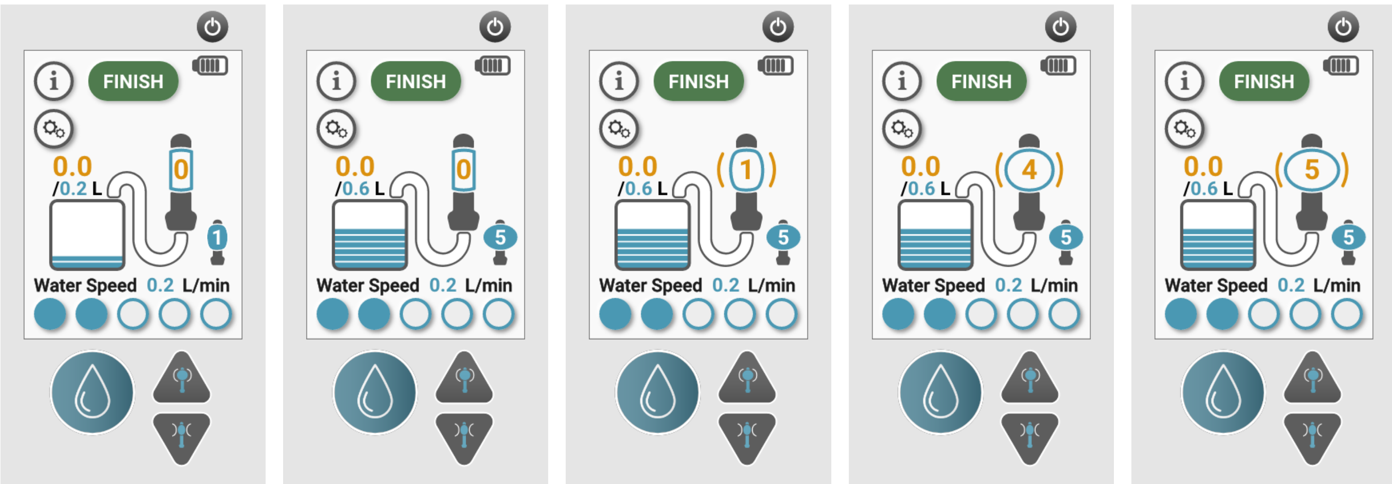


Figure 34: the prototype showing screens from the treatment stage and when inflating the balloon.

Irrigating

To irrigate water, the user presses the physical water button. When pressed the tube of the interface goes from being empty to be filled with blue circles representing water and three droplets are shown above the catheter to show that there is water moving and pushed out of the catheter when pressed.

The orange number to the left is counting the level of water which has been expelled. This was one of two numbers (water level and balloon size) which the users were most keen on looking at from the interviews with users and from the user tests. Therefore, this number is made orange to easily be distinguished from the other aspects of the UI.

Figure 35: the prototype showing screens from the treatment stage and when irrigating.

When the orange number is counting up the water level is going down in the tank which shows that water has been used. For each 0.1L one blue bar in the water tank is replaced with a grey bar which represent that the water is gone in that part. This can be seen when going from image 2 to image 5 in figure 35.

Some users also expressed that they did not know that it was possible to change water speed on the unit and placing the water speed in the treatment stage instead of in the settings page it will become more apparent for the users that it is possible. Having the water speed in the treatment stage also makes it possible for the user to explore what water speed works for them. Some users are also encouraged to choose a slower speed to start with from healthcare professionals. Having the setting for water speed in the UI it is possible to more gradually increase to speed for the users who use a higher speed. The water speed setting is designed to show the speed both by showing the speed using a number to be able to compare to the water level and to give a real life understanding of how fast the water is irrigated. The buttons also indicate the level from 1-5 by how many of the buttons are filled.

Deflating

When the user is done instilling water and has waited a while the users deflate the balloon by pressing the deflate button. When pressing the deflate button there are orange indicators appearing around the balloon which gives the user feedback that there is something happening to the balloon which can be seen in image 1, 3 & 4 in figure 36. They are made orange as they are the most active thing happening in the interface and orange pops out in the UI. When deflating the balloon, the number inside counts down until reaching zero and the size of the big blue balloon is increasing simultaneously.

Figure 36: the prototype showing screens from the treatment stage and when deflating the balloon.

9.3.5 Review

The key aspect of creating the review of the treatment is to create something which the user can bother doing. Therefore, making it fast and easy to perform was important. As discussed previously, producing data which the healthcare professionals can use can make for more knowledge which can help researchers to understand the bowel more.

Writing on the quite small resistive touchscreen using a touch-keyboard is not optimal and writing answers each time is time-consuming and might be frustrating. Displaying information which the user can read and press to choose is therefore an option which is chosen instead. When user testing some users preferred that less information was shown to them at a time, and this was taken one step further in this concept. By providing less information at each step the user does not have to process as much information and each button can be made larger.

The three steps in the review process is first to input if the user had any issues, then to rate the satisfaction with the treatment and the feeling in the bowel and lastly to say if they have had any bowel movement since last irrigation. This data is grouped together with the data from the treatment such as time, water level, water speed and balloon size.

The first step of inputting any issues is done in steps. The first step provides four categories of issues which the user might have had. If the user has had any issue of a category s/he pushes that box which then turns blue to indicate that it has been pressed. If no issues have been had the user does not press any box. To continue the user presses the green button with an arrow pointing to the right. If the user has had issues the category of issues is presented with subcategories. The second image in figure 37 shows issues in the "PAIN AND CRAMPS" category which then has been selected in the first image.

The second step in the review is to say on a 1-5 scale how satisfied the user was with the treatment and how the bowel feeling is after the treatment by pressing smileys. The smileys indicate the feeling of satisfaction which the user might relate to and shows that a 3 is a neutral number in this case.

The third step is to indicate if the bowel has moved anything since last time the user irrigated. Colors were removed in this step as they could indicate that one is better than the other while the most important thing is that they input the correct thing. Therefore, they were changed to white. Text was chosen instead of symbols as this was preferred in the user studies. When the user presses the answer, which is correct for them they are taken to the quit action where they can either look at their answers or turn of the unit.

The data provided this way compared to inputting via writing text is easier to interpret as it is easily put into categories but lacks detail in the answers as there are only the assigned answers which can be chosen compared to text input.
The topics regarding what could be asked about in the review was provided by Wellspect.

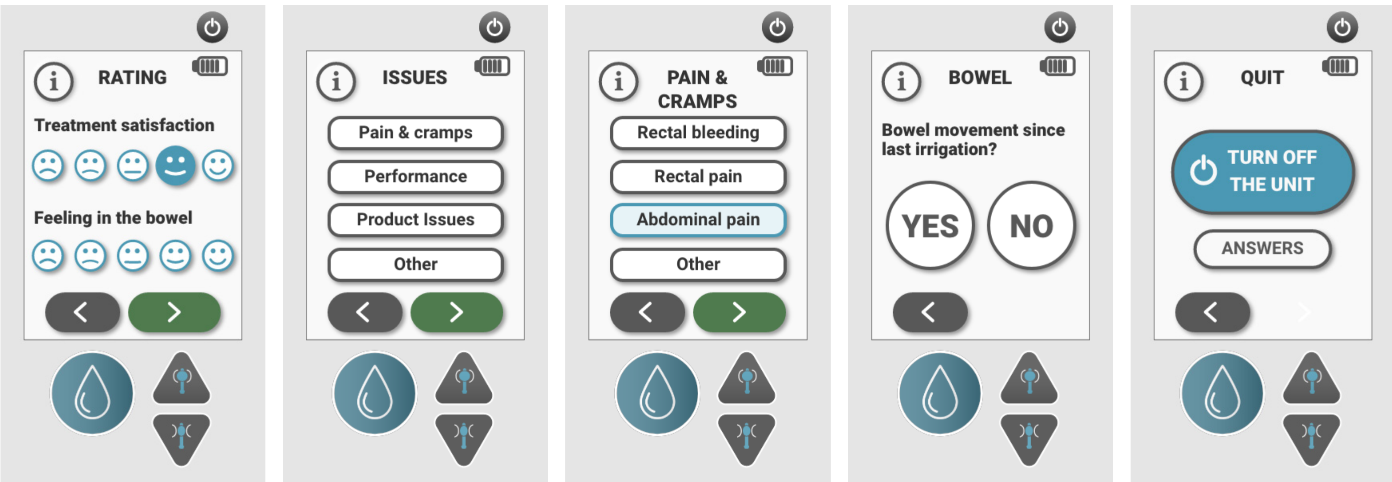


Figure 37: the prototype showing screens from the review.

9.4 Extra Features

Other than the main treatment screens there are also some more features to the UI which are discussed in this chapter.

9.4.1 Guides

The guides feature which can be activated in the "FUNCTIONALITIES" tab in settings is the information screen appearing automatically. This could be used for new users to provide them with information directly. This functionality will most likely be turned off after a few usages when the user has understood how to perform the treatment correctly. Having the guides appear automatically also makes the user understand where to find the information better by animating the information screens out and in from the information button in each screen. The image in figure 38 shows the information screen for priming which would appear automatically to say why priming is done.

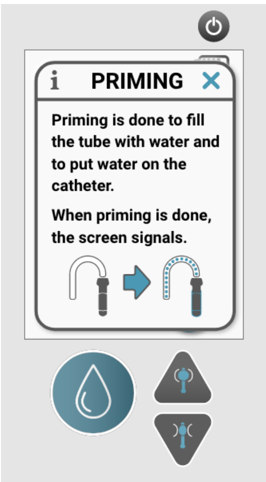


Figure 38: the prototype showing an example of an information box, in this case the priming information.

9.4.2 Battery

From the interview some users expressed that they had an issue with knowing how much battery is left and when to change the unit. The battery issue is not one only to be solved by improving the UI, it also needs clear instructions to the user regarding when to charge. The update from the current Navina Smart version is that the battery indicator is larger with clearer distinction between each bar. The bar also changes to red when battery is low and thus is not able to perform a complete treatment. The battery bar follows the user during the whole process of using the product except for in the settings menu and when the information window is shown. In figure 39 the battery bar is shown with its five levels and illustrations of how the battery can look in each stage of performing the treatment.

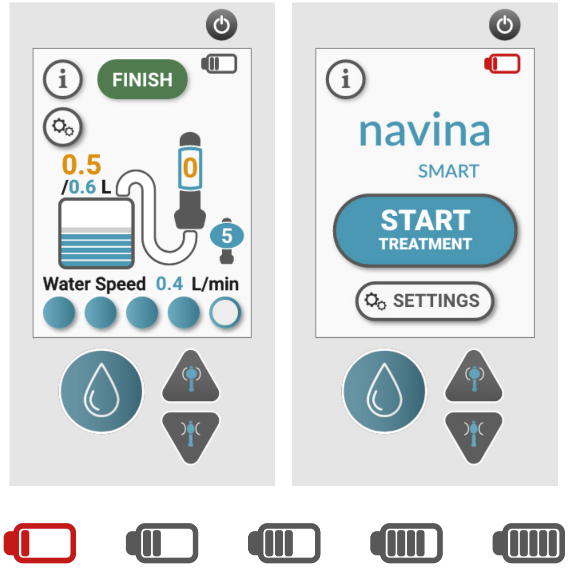


Figure 39: the prototype showing how the battery bar can look with varying amounts of battery left.

9.4.3 Warning Message

The idea for the error messages is to be more descriptive than the current warning messages. Now the code for the error message is shown with no more information. In this warning message example, the code is still present as a language-universal way of search for more information regarding the warning message and as way of communicating it to Wellspect staff. Red is used for the warning sign to help to indicate that there is an issue regarding something. In the error message box, a short description of the warning is shown and a possible action to be taken. Some warnings allow the user to dismiss the warning to continue with the treatment while some require the user to restart the unit.

Figure 40: the prototype showing an example of a warning message.

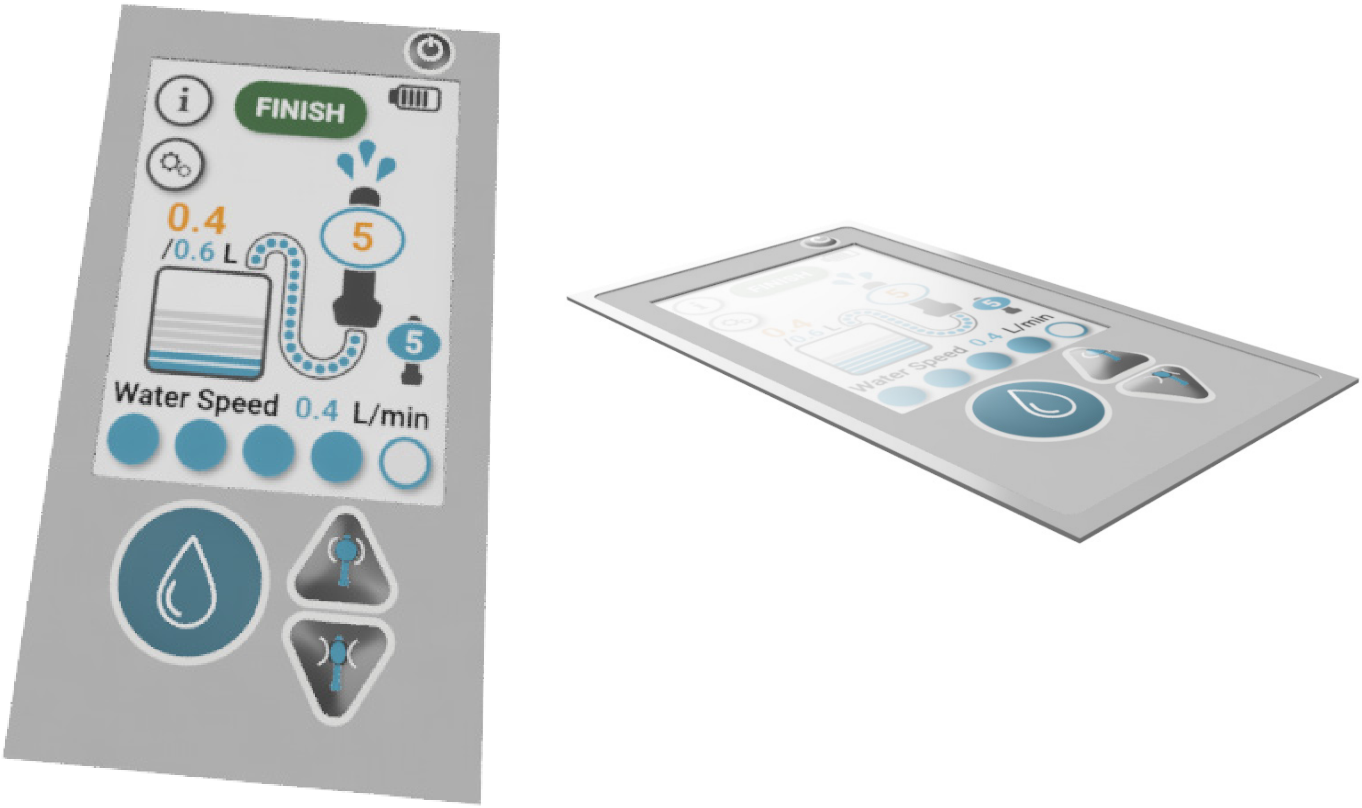


Figure 41: renderings of the UI done in Autodesk Fusion 360 to show the buttons and screen in 3D.

9.5 Renderings

To visualize the buttons three-dimensionally computer renderings were done. The renderings were done using Autodesk Fusion 360. In the renderings it is easier to get an understanding of how it would look like in reality as it is shown in an angle and the buttons have height and roundness which is not shown in the pictures made in Adobe XD and Adobe Illustrator as they are two-dimensional.

9.6 Interactable UI

As with the version made for the digital prototype test, the updated version is also made in Adobe XD to be able to interact with. Opening the interface on the phone, clicking on the buttons and seeing the animations gives a more realistic experience. It also gives a handheld experience even if the phone is not the same size as the unit of the Navina Smart. Delivering an interactable prototype which can be opened of a phone makes it possible for Wellspect to experience the product more realistically and to use for future testing.

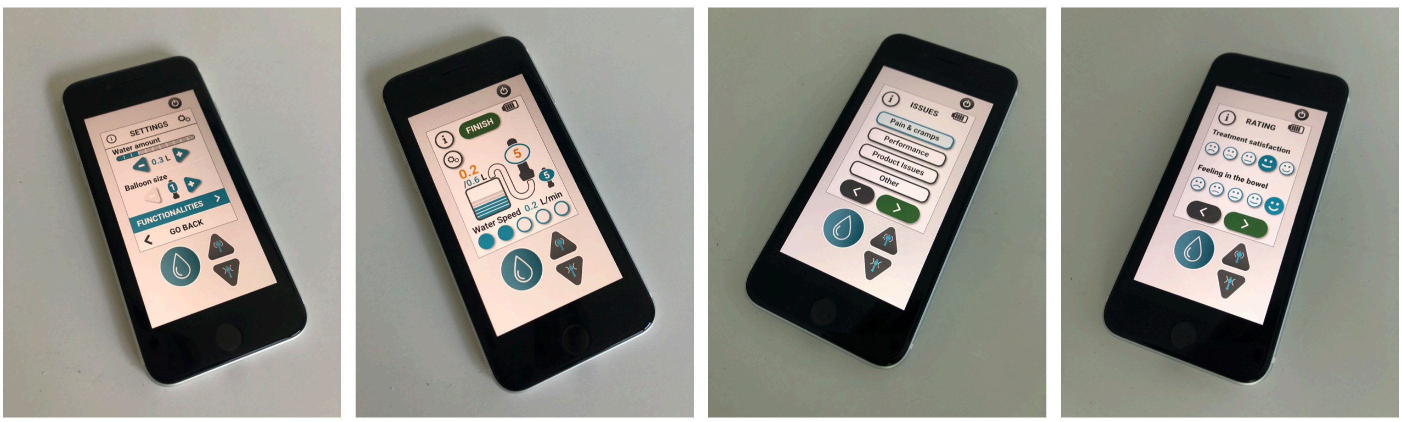


Figure 42: the new digital prototype presented on the phone to be able to perform tests.

9.7 Physical Prototype

The physical prototypes were not evolved further after choosing to continue working on the version with physical buttons. This was partly due to time prioritization and partly as the things that needs to be done to the new version of the physical prototype do not revolve around the subject of the thesis as much as the digital UI. The physical prototype buttons should be changed the shape of the buttons in the digital prototype and the new icons should be added to align with the digital prototype.

9.8 Final Prototype Summary

The insights blocks and the final prototype block has focused on usability aspects and therefore the final prototype has been shaped from this point of view. The process which has shaped the final prototype also has a usability-centric point of view and therefore it helped to shape the project according to usability aspects. The design of the final prototype has focused on the digital prototype as it is influenced by the insights more and the changes of the physical prototype can easily be done by the company.

Designs have been made for all aspects of using the interface, from starting the device, changing settings, priming, inflating the balloon, instilling water, and reviewing the treatment. Designs has also been made for receiving information about the current state of the treatment and for warning messages which has been designed to help the user to learn how to perform the treatment and how to avoid misuse.

The final prototype relies on the insights made from previous blocks to be appropriate for the users. Aspect which has not been brought up by the first three blocks and in the covered theory has therefore not been taken into account. This is why further iterations need to be done, both to test the viability of this prototype and to cover more aspects.

10.
DISCUSSION

This chapter contains a discussion about the final result and how it compares to the scope of the project and the expected outcomes for company. The chapter also discuss challenges in the project, ethical aspect and sustainability aspects.

10.1 Scope

During the project it has been difficult to limit the aspects which are to be included as many parts goes together such as the shape of the handheld device and what functionalities to include in the UI.
To be able to move forward and come to conclusions regarding something many aspects has to wait for future development. Focusing on the interface with the screen and the buttons has made it possible to go deeper and understand how aspects of the interface and the user interaction can be thought of to end up with a satisfied user. The aim of the project was to create an intuitive and positive user experience and thus the focus was the parts regarding this topic. The interviews, user testing and literature study all has focused on understanding the user's perspective to make the experience better. These insights have then been used to create the final prototype design and therefore the thesis has stuck to its aim.

The idea of the thesis has also not been to create the final design of the next Navina Smart, instead it has been to enable continued iterating and doing tests to gain insights regarding the users and the product. The final prototype design is therefore intended to be used as a tool for further development and the insights have been used in the development of the prototype and can be further used in future development. Ending with a functional prototype which is based on research is therefore reaching the aim of the thesis.

10.2 Process

When starting the project there were very little information about the users and thus the first thing was to try to understand them better. Various issues, such as GDPR paperwork and ordering of prototype component, pushed the interviews and prototype tests forward and made them to be worked on in parallel. As they produced results simultaneously their results did not affect each other which has its pros and cons. Having the interview insights before making the prototypes could have made the prototypes easier to use but not having any insights made it more natural to design more similarly to the current Navina Smart unit and this might have produced insights more similar to using the original product. There were already a lot of time put into making the prototypes and therefore performing the tests faster to gain insights from them was priorities before changing the prototypes based on the interviews.

As knowledge about the users were needed in this project and for Wellspects future development of the product the insights part of the project took up a large part of the thesis. Updating a medical device takes many years and thus providing insights which can be used throughout the development is thought of as more important than to come up with final designs. New aspects might make the design flawed but the user insights will still be relevant.

The thesis ends with designing a digital prototype based on the insights gained from the three blocks. This prototype is not evaluated but is based on insights gained throughout the project. Ending with a final design is also what is done in a basic design cycle as described in chapter 3.13. The R&D team at Wellspect does not have any designers and thus leaving them with a new design which is able to be tested was considered a better idea than to have the next step being to design based on insights. It is easier for them to continue the work as they can continue to perform similar and other user tests as described in future development in chapter 10. The latest design also shows how the insights from the first parts are used to design a new version.

10.3 Prototypes

A large part of the project was to develop prototypes in order to investigate how things are perceived by humans. Physical prototypes were made to investigate how people perform and experience buttons and digital prototypes were made to investigate how the allocation of screen and buttons is experienced differently when having three fixed buttons and a screen or a larger screen with no fixed buttons.

The digital and the physical prototypes which were made in the project can be considered to be high fidelity. This choice was made for the physical prototype as the purpose of the test was to understand the differences. Creating a task for the testers to perform made it possible to put their experience in relation to something and it also made it possible to measure their performance with the two alternatives. The choice of making it possible to pump air and water such as the current Navina Smart was due to that it was a relevant task as well as it was known technology for the engineers helping to build the prototypes. Other versions of the physical prototypes could be made easier such as pressing tests with no task, using easier tasks such as having something appear on the screen instead of physically, but those options were not seen as being able to give enough information. This level of fidelity was seen as a good way to put the performance and control in relation to the actual task even if the product was not used in the same context. The shape of the physical prototypes was also made to not look like a final product as the shape of the device was not in focus. Therefore, a boxy shape able to fit all the components for the prototype was made to be easy to iterate inside. The shape was commented on as it was not very pleasant to hold but it was the same for both versions. There are many aspects of using the buttons and the test focused on control as it was understood as important when inflating a balloon and instilling water rectally. Something which was not tested was comfort, how the user experienced holding the buttons for a longer period of time could be tested as pumping the water takes a while, especially on the slower speeds, and thus the user needs to keep a button pressed for a while. There are probably differences in holding a physical button and a resistive touch button down for a period of time.

The digital prototypes were made fairly high fidelity as the broader concept was already fixed by how the treatment works. Thus, looking into how the interactions for the actions around the treatment was focused on. The digital prototypes which compared the interfaces which can be designed with a larger screen and with a smaller screen with three fixed buttons were made in Adobe XD and tested on a phone and thus the physical buttons in these prototypes also became digital. The test is testing what it is supposed to test but the dimension of having physical buttons when interacting with the UI is not taken into account in this case. The digital prototype test was performed by going through instructions and the test persons were not very aware of all aspects of the user. But the comparison between the two version in terms of easiness to use was still able to be done and aspects of usability was brought up. As it was not possible to meet with the current users in person a more high-fidelity prototype was used as it informs the user more and thus the test persons can more easily understand the relation between instructions and prototype. Because the digital prototype did not do anything physically this dimension is also missing, as the real product would inflate a balloon and irrigate water, but this version did only do actions on the screen. The digital prototype is also faster to use than a real use case as it would take too much time to instill at a slow speed two times for every test person, but this can be taken into consideration.

There is potential to miss aspects at a higher level as it gets more focused on detail. But as the users in the test is not as aware of the intended use it could be more difficult for them to think of the experience as a whole.

10.4 Working with Medical Devices

There are some difficulties that arise when working with medical devices and devices which have people with functional variations as target group. As GDPR states that medical conditions are sensitive information there are more paperwork needed and stricter conditions apply. This was understood before the thesis but the extent of it and the time needed to spend to make everything align with GDPR was much more than expected.

Working with medical devices also require lots of testing and to apply to regulations. Therefore, this project is seen as a way to give the company insights on how to continue to improve the current product instead of saying that this is a final solution because there are so much more going into making this kind of product. This kind of medical device which require the user to insert a catheter, inflate a balloon and irrigating water into the bowel require lots of paperwork to be tested and certified as a malfunctioning product can inflict damage to the user. As much testing as possible should therefore be done to ensure that when testing to insert a catheter with a new version of the product, it should be as thought through as possible.

10.5 Test Results

The tests were done in a lab environment for both the test with the digital prototype and for the physical prototype. The prototypes were not tested for their intended purpose as it can be sensitive, and it was not possible to meet the potential users due to the pandemic. Using a lab environment and making other assignments than what the product is assigned to do could have an impact on the data. A hypothesis is that the users using the product would value the control more than the test people in the prototype tests as they know how the product is used. This could therefore change the data of the experienced control for the prototypes.

10.6 User

The method of the project has pushed the user needs to be at the core of the project which hopefully has resulted in a prototype which is better for the user. The user test of the first digital prototypes showed great potential as the users had not seen a similar interface and performed well in doing the tasks presented to them. The latest prototype then got updated based on more literature, the users test results and the interview insights and should therefore perform better than the last prototypes in the tests. But as found during the thesis there are multiple different kinds of users with different functional variations and users who are assistants to the person receiving the treatment. The interviews are also made with users which are quite experienced as it was those users who were willing to be interviewed when contacted by the company. The final prototype therefore is based mostly on data from the interviews with people which may not be representative of the whole user population. It could therefore be beneficial to try to understand the users not represented by the interviews further to continue to iterate the prototype.

10.7 Company

Wellspect wanted insights on how the Navina Smart unit could be improved in terms of user experience and that the deliverables should be something they could use for further development. The thesis therefore aimed at creating understandings of the context to deliver. This is also done by providing prototypes which Wellspect can use to test and continue iterating. The deliverables made in form of interview transcripts, insights from the interviews and insights from the digital and physical prototype tests can be used by the company to understand the current users and new users' perspective on the UI. The thesis also suggests future development areas which have been noticed in the project for the company to choose to continue with if they consider them to be of importance to the product.

10.8 Challenges

One of the key challenges to making this interface was to provide a lot of things for the user while still having the UI to be easy to understand. From the current interface there are multiple things added such as information buttons, a settings button and water settings on the treatment screen which adds complexity. Adding the review section and making it possible to irrigate again in the interface also adds complexity to the process. Literature, interviews and user testing had to guide how the different items were prioritized and placed in the UI. Less used items were made smaller and if a part of the UI could be hidden behind something in an understandable way this was done.

Covid-19 was one of the largest challenges as it made it more difficult to work close to the R&D team, to find people to test the prototypes and to communicate with the target user groups. When it came to the user tests, the company discussed how this could be made in a safe way and decided to use participants who were already on site and distance was kept during the test. After each participant had used the prototypes, everything was sanitized. It turned out well as the prototype was able to be tested but Covid-19 made everything regarding planning and executing the test much more difficult. If there would be no pandemic bringing the prototypes to people with lower hand dexterity and thus test with a target user group who would have more difficulties with the prototypes would be possible.

10.9 Sustainability

In this project social sustainability has been the focus as the product helps the user to easier be a part of society. While the product does not have a focus on environmental sustainability it is still something that should be taken into consideration. The level of sanitation required for using such medical devices often required single use products and chemicals for disinfecting. The users' medical needs will have highest priority but opportunities for an increase in environmental sustainability for the solutions should be explored where see fit in the future. There have been no measures taken to improve on ecological sustainability for the product but a result of an easier to use product has the potential to perform the treatment more correctly and thus not damage the device as much increase the lifespan of the product.

10.10 Ethical Aspects

There is an ethical aspect of how far you can go to design for the people with the biggest needs while still maintaining the users with not as big of a need to have a special needs product. The product is a great fit for people with disabilities but to be more profitable it still needs to cater to a wider audience.

Transanal irrigation can be a sensitive topic and therefore it was important to respect the users and make them feel comfortable when interacting with them as was done in the interviews. This was done by starting the interviews with saying that they did not have to answer each question if they did not feel like it and by asking the more sensitive questions in a wat that the interviewee can share the amount that they are comfortable with.

10.11 Industrial Design Engineering Relevance

This thesis has presented multiple challenges which have been faced with the tools that have been given in the Industrial Design Engineering education. The thesis has focused on the users need in relation to the product by interviewing and testing. Knowledge about physical and digital aspects of product development has been used when 3D-printing and developing digital interfaces for testing.

The thesis has also put relevant aspects of physical and digital product development in relation to theory to discuss how to improve the current interface. Because the thesis uses a design process and touches on multiple aspect of the education it can be argued that the thesis is relevant in the field of Industrial Design Engineering.

10.12 The Device in Society

This device's role in society is both to help the users needing this product, the people around the product and people receiving data which can be used for research. This product is made to solve a problem which is very frustrating for the users. The great extent the product helps the user not only benefit the users of the treatment but everyone around them who wants to socialize or work with a user of the product. The product is expressed by the users to be a life changer in terms of how much it benefits them. Improvements made to the Navina Smart can be seen as a way to make the users stick to the device, increase the willingness to share the experience, and for others to understand how the product functions. These aspects help more people to be more comfortable using the product and thus have the same great experience as the users from the interviews have.

This version will also contribute to bowel research as it can create more accurate data when it can show if users perform multiple irrigations after each other instead of showing multiple separate irrigations. The data will also be improved as this version has an easier to perform treatment review which also will contribute to the data and to bowel research. More knowledge about the bowel then can create knowledge about the illnesses caused in the bowel to be able to prevent and treat them.

11. ANSWERS TO RESEARCH QUESTIONS AND FURTHER DEVELOPMENT

In this chapter the research questions are answers as conclusions and suggested further development is presented.

11.1 Research questions

Following is each research question presented and answered based on the information gathered in the research.

Which factors makes the use of the product intuitive and what is considered a positive experience in relation to the use of the product? Also, which kind of positive experience is it that the product wants to accomplish?

When interviewing the users and the nurse their answers suggests that there are no particular issues when it comes to the use of the interface for them at this moment other than error messages appearing when they use the product incorrectly. When the interviewed users reflected on what issues they had as new users they stated that it could be difficult to understand each step and how to move forward. The product has therefore have tried to give the novice user an easier time of understanding the product as it has been one of the main frustrations.

The main positive thing which the UI can give to the user is to make the use of the product as efficient as possible, because the users express that this task is something they only want to be done with. Providing information about how to do things and what causes the errors in the interface is also seen as a positive experience as it solves the users issue with not understanding some aspects of the use of the product.

How can the design of the interface and the buttons of the product give the user a sense of control even if some aspects of the interaction are automated?

Control partly comes from receiving correct and adequate feedback and thus the interface is giving feedback in multiple ways. The UI both gives the user feedback of what is currently happening and how far the user has come in the treatment when it comes to balloon size and water level. Feedback which is more used such as current water level and current balloon size is made large and in orange to differentiate itself from the other aspects of the UI, this can make it easier for the user to follow the treatments progress.

Some users state in the interview that they have issues with pressing the buttons on the current Navina Smart unit and thus this was a target area for the thesis. Having issues with pressing the buttons mean that they can have issues with inflating the balloon, irrigating water and deflating the balloon which can be frustrating for the user. Control was thus tested of two types of buttons, resistive touch and physical buttons which indicated that users performed better with physical buttons and felt more in control using them. Therefore, this option was used for the final prototype. The tests with the first digital prototypes showed that the user could follow the illustrative feedback and the numbers and that it was going well enough for the assignment. Although both tests showed that the users felt in control when using the prototypes, the lab environment is different than actually using the product at home. But for this to be tested a much more developed prototype and more paperwork is required.

How can the interaction with the product be both informative enough to guide a beginner while still be efficient to use for an experienced user?

The current unit is experienced by the interviewees to be easy to use and the users express that they do not have any issues other than the error messages and the buttons. As told by the nurse and the interviewee, when the users are new, they can experience issues with using and understanding the product. The novice users need help in understanding, and the experienced users want to retain their efficiency in using the product and thus the help for the novice users should avoid getting in the way of the experienced users. The solutions to this have been to provide clear feedback such that the novice users understand what is happening and to provide information boxes where things might be unclear. These information boxes can be used by the novice users and ignored by the experienced users.

How do the suggested improvements affect the users, the salespersons, the nurses and the R&D department?

There are multiple suggested improvements which will affect the users, salespersons, nurses and R&D if implemented. The physical buttons will provide the users with more tactile feedback which according to literature should have a positive effect on learning to use the UI. The information boxes and warning messages should make it possible for the users and other stakeholder to learn how to go about making the treatment and how to avoid errors.

The new review process of checking boxes after the treatment in the UI has the potential to improve the situation for everyone. The nurses will have more information about each user to be able to make better recommendations for them and the users will be able to be better handled. Healthcare professionals and the R&D team will potentially receive more data to improve bowel healthcare and the salespersons will have more argument for why this product is a good choice to use.

Having physical buttons could also benefit the R&D department as they have had issues with the current touch-buttons and physical buttons remove the issues of fingers not being placed properly and being too wet or too dry.

11.2 Further Research and Development

There are a lot of things that can be done to further explore, understand and develop this product.
This project has only been a study to explore issues and potential designs to an update of the Navina Smart. There are both things in the area of this project who can be further developed and to the product as a whole. There have been many issues regarding Covid-19 and thus there are more potential tests and developments which can be conducted after the pandemic. Suggestions to delve deeper into for the product is to:

Evaluate the final interface with the users
The last interface designed and presented in the thesis is based on theory, interviews and prototype tests but is still in need to be evaluated to find out if the design is successful or if there are aspects which needs to be changed. When it is possible to test with users of the current Navina Smart unit (as it has not been due to Covid-19) it is recommended to also do that as they are able to compare the current version with the new and updated version. As in the test performed in this thesis, users who have no understanding of the unit can also be tested with to understand how new users interpret the interface.

Include assistants to the patient as a user type
The assistants were discovered as a type of user from the interviews with the users who had assistants. As the persons receiving the treatment expressed that they often had new assistants which they have to teach and as the assistant themselves do not use the unit they have different need then the users. By including assistants in the interviews and user tests it is possible to gain new insights which can benefit the assistants which in turn can benefit the user receiving the treatment.

Test the two prototypes with users with hand function variability
Many of the people with hand function variability have other issues as well or are elderly which made them a risk group in the Covid-19 pandemic. The user tests therefore included healthy people. When it is possible, the digital and physical prototypes should be tested with users who have issues with their hands as this is an important target group for the Navina Smart unit. The prototypes could then also be updated to have the new UI and the version with physical buttons should change into round membrane switches to be more accurate to what the concept might be in the future.

Sound feedback
This is mentioned in the functionalities part of the treatment chapter in final prototype. Sound feedback is a possibility which could be included into the interface if it can be shown that it can help some users in any way. Interviewing current users about this topic and testing sounds with the prototypes could be the first step to figure out if this can have a positive impact on the use of the product. This can be beneficial to people with decreased vision, and users who want to do other things simultaneously.

Treatment without touch
This is a concept which is mentioned previously in the thesis and concerns being able to make the treatment only using the physical buttons. This can especially be valuable for those with less dexterity in their hand as they only would have to press the three larger buttons and not have to press the digital screen. This needs to be tested to see if it is possible and necessary as the user might want to only use some touch screen buttons and move around in the UI with the physical buttons where it is fitting for them. The shape of the physical buttons can be a good fit for this as there are two arrows pointing up and down and a round button which could be used for selecting the targeted item in the UI. An example of how this could look can be found in appendix 11.

Water container size

As it is shown, some users perform multiple irrigations and if the user use more than what the water container can fit, it needs to be filled again and thus primed again. This can be solved either by making larger water tanks or by having the unit detect that there is not enough pressure in the tank and showing the priming screen in the UI, and when primed the user can go to the treatment UI.

Handheld unit shape

In this thesis the buttons and the UI has been investigated and designed but nothing has been done in terms of the shape of the device around the screen and buttons. The shape of the device plays a role in how the user handles the device and reaches the buttons and items on the screen. Shaping the physical device and taking the users who have different needs in terms of handling the device into consideration should be made in order to test the different parts of the prototype as a whole to get a more nuanced experience. When developing the shape for the device it is possible that changes to the interface needs to be made such as button placement, which is affected by the shape and size of the device.

REFERENCES

Apple Developer (2021b) *Human Interface Guidelines* - App Icon Retrieved 2021-03-05 from https://developer.apple.com/design/human-interface-guidelines/macos/icons-and-images/app-icon

Apple Developer. (2021). *Adaptivity and Layout.* Retrieved 2021-03-04 From https://devel oper.apple.com/design/human-inter face-guidelines/ios/visual-design/adaptivity-and-layout/

Arvola, M. (2014). *INTERAKTIONSDESIGN och UX.* Lund: Studentlitteratur. Bar, M & Neta, M. (2006). "Humans prefercurved visual objects". Psychological science. 17. 645-8. 10.1111/j.1467 9280.2006.01759.x.

Brewster, S Chohan, F. & Brown, L. (2007). *Tactile feedback for mobile interactions.* In Proceedings of the SIGCHI Confer ence on Human Factors in Com puting Systems. Association for Com-puting Machinery, 159–162. DOI:https://doi.org/10.1145/1240624.1240649

Caprani, Niamh & O'Connor, Noel & Gurrin, Cathal. (2012). *Touch Screens for the Older User.* 10.5772/38302.

Chandra, S. (2019). *Gestalt Principles — Learn how to influence perception.* Retrieved 2020-09-21 from https://medium.com/ringcentral-ux/gestalt-princples-learn-how-to-influence-perception-83112932d0bc

Chao, J., Plocher, T. & Liana, K. (2007). *Touch Screen User Interface for Older Adults: Button Size and Spacing.* Lecture Notes in Computer Science. 4554. 933-941. 10.1007/978-3-540-73279-2_104.

Dandekar, K., Raju, B. I., Srinivasan, M., A. (2003). *3-D Finite-Element Models of Human and Monkey Fingertips to Inves tigate the Mechanics of Tactile Sense.* Journal of Biomechanical Engineering, Vol. 125, 682 - 691. doi: 10.1115/1.1613673

Designmondo. (2016). *Rounded Corners and Why They Are Here to Stay.* Retrieved 2021-03-05 https://designmodo.com/rounded-corners/

Eve Hoggan, Stephen A. Brewster, and Jody Johnston. 2008. *Investigating the effective ness of tactile feedback for mobile touch screens.* In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08). Association for Computing Machinery, New York, NY, USA, 1573–1582. DOI: https://doi.org/10.1145/1357054.1357300

Feist, G.J., & Brady, T.R. (2004). *Openness to experience, non-con- formity, and the preference for abstract art.* Empirical Studies of the Arts, 22, 77–89.

Gould, John & Lewis, Clayton. (1985). *Design for Usability: Key Principles and What Designers Think.* Commun. ACM. 28. 300-311. 10.1145/3166.3170.

Greenhalgh, Scott. (2016). *The effects of 3D printing in design thinking and design education.* Journal of Engineering, Design and Technology. 14. 752-769. 10.1108/JEDT-02-20140005.

Hekkert, P. (2006). *Design aesthetics: Principles of pleasure in design.* Psychology Science. 48.

Hustwit, G. (2018). Rams. [Film]. USA: Film First Co.

Interaction Design Foundation. (2021). *Dressing up your UI with colors that fit.* Retrieved 2021-03-02 from https://www.interac tion-design.org/literature/article/dressing-up-your-ui-with-colors-that-fit

Jones, N.A. Ross, H., Lynam, T. Perez, P., Leitch, A. (2011) *Mental Models: An Interdisci-plinary Synthesis of Theory and Methods*, Ecology and Society 16(1): 46.

Lidwell, W., Holden, K. & Butler, J. (2010). *Universal Principles of Design.* Beverly:Rockport.

Material Design. (n.d). *Accessibility.* Retrieved 2021-03-04 From https://material.io/design/usability/accessibility.html

Material Design. (n.d). *Light and shadows.* Retrieved 2021-02-03 From https://material.io/design/environment/light-shadows.html#light

Milton, A., & Rodgers, P. (2013). *Research Methods for Product Design.* London: Lawrence King Publishing.

Monö, R. (1997). *Design for Product Understanding.* Stockholm: Liber.

Muller, W. (2001) *Order and Meaning in Design.* Utrecht: Lemma Publishers.

Nagarajan, Kamya & Silva, Arlindo & Lee, Hyowon. (2020). *Insights for touchscreen interface for medical devices: A case study of a usability test.* DS 101: Proceedings of NordDesign 2020, Lyngby, Denmark, 12th - 14th August 2020

Norman, A. D. (2013). *The Design of Everyday Things.* New York: Basic Books.

Norman, A. D. (2016). *Living with Complexity.* New York: Basic Books.

Norman, D. A. (2002). *Emotion and design: Attractive things work better.* Interactions Magazine, ix (4), 36-42.

Office of Disease Prevention and Health Promotion. (2016). *Display Content Clearly on the Page.* Retrieved 2021-03-04 from https://health.gov/healthliteracyonline/display/section-3-3/

Osvalder, A.-L., & Ulfvengren, P. (2015). *Människa-Tekniksystem.* In M. Bohgard, S. Karlsson, E. Lovén, L. Å. Mikaelsson, L. Mårtensson, A. L. Osvalder, & P. Ulfvengren, Arbete och teknik på människans villkor (p. 353-438). Stockholm: Prevent.

Parhi, P., Karlsson, A. K & Bederson, B. B. (2006). *Target size study for one-handed thumb use on small touchscreen devices.* In proceedings of the 8th conference on Human-computer interaction with mobile devices and services (MonileHCI '06).

Preece, J., Rogers, Y. & Sharp, H. (2015). *Interaktionsdesign: bortom människa-dator-interaktion.* (1. ed.). Lund: Studentlitteratur.

Preece, J., Rogers, Y., Sharp, H. (2002), *Interaction Design: Beyond Human-Computer Interaction*, New York: Wiley, p.21

Rams, D. (2014). *Less but better*. Berlin: Gestaleten.

Rasmussen, J. & Vicente, K. J. (1989) *Coping with human errors through system design: implications for ecological interface design,* International Journal of Man-Machine Studies, Volume 31, Issue 5, Pages 517-534, ISSN 0020-7373, https://doi org/10.1016/00207373(89)90014-X.

Reimer, B., Mehler, B. & Donmez, B. (2014). *A study of young adults examining phone dialing while driving using a touchscreen vs. a button style flip-phone.* Transportation Research Part F: Traffic Psychology and Behaviour, Volume 23, 2014, Pages 57-68, https://doi.org/10.1016/j.trf.2013.12.017.

Science Focus. (2017). *Why do we find circles so beutiful.* Retrieved 2021-03-05 from https://www.sciencefocus.com/science/why-do-we-find-circles-so-beautiful/

Stolterman, E. (2008) *The Nature of Design Practice and Implications for Interaction Design Research.* Interaction Journal of Design, Vol. 2(1). pp. 55-65.

Troncoso, X., Macknik, S. & Martinez-Conde, S. (2008). *Corner salience varies linearly with corner angle during flicker-augmented contrast: a general principle of corner* *perception based on Vasarely's artworks.*

UX Planet (2016). *Buttons in UI Design: The Evolution of Style and Best Practices.* Retrieved 2021-02-03 from https://uxplanet.org/buttons-in-ui-design-the-evolution-of-style-and-best-practices-56536dc5386e

Van Boeijen, A., Daalhuizen, Å. & Zijlstra, J. (2020). *Delft Design Guide.* Amsterdam: BIS Publishers.

Vårdhandboken. (2020). *Analinkontinens - vård och behandling - Översikt.* Retrieved 2020-03-10 from https://www.vardhandboken.se/vard-och-behandling/tarmfunktion/analinkontinens---vard-och-behan dling/oversikt/

Vårdhandboken. (2021). *Förstoppning- Översikt.* Retrieved 2020-03-10 from https://www.vardhandboken.se/vard-och-behandling/tarmfunktion/forstoppning/oversikt/

Wallach, D., Scholz, S., C. (2012). *User-Centered Design: Why and How to Put Users First in Software Development.* In: Maedche A., Botzenhardt A., Neer L. (eds) Software for People. Management for Professionals. Berlin: Springer

Weinschenk, S. M., (2011). *100 Things Every Designer Needs to Know About People.* Berkeley:Pearson Education, Peachpit.

Wellspect healthcare (n.d.a). *Common Bowel Problems.* Retrieved 2021-03-10 from https://www.wellspect.co.uk/bowel/common-bowel-problems

Wellspect. (n.d.b). *How TAI works.* Retrieved 2020-09-24 From https://www.wellspect.co.uk/bowel/what-is-tai/how-tai-works

Wellspect. (n.d.c). *What is TAI?* Retrieved 2020-09-24 From https://www.wellspect.co.uk/bowel/what-is-tai

Wellspect. (n.d.d). *Navina Smart.* Retrieved 2020-09-24 From https://www.wellspect.se/produkter/tarmprodukter/navina-smart

Werner, L. (Ed.). (2017). *Cybernetics: state of the art.* Berlin: Universitätsverlag der TU Berlin

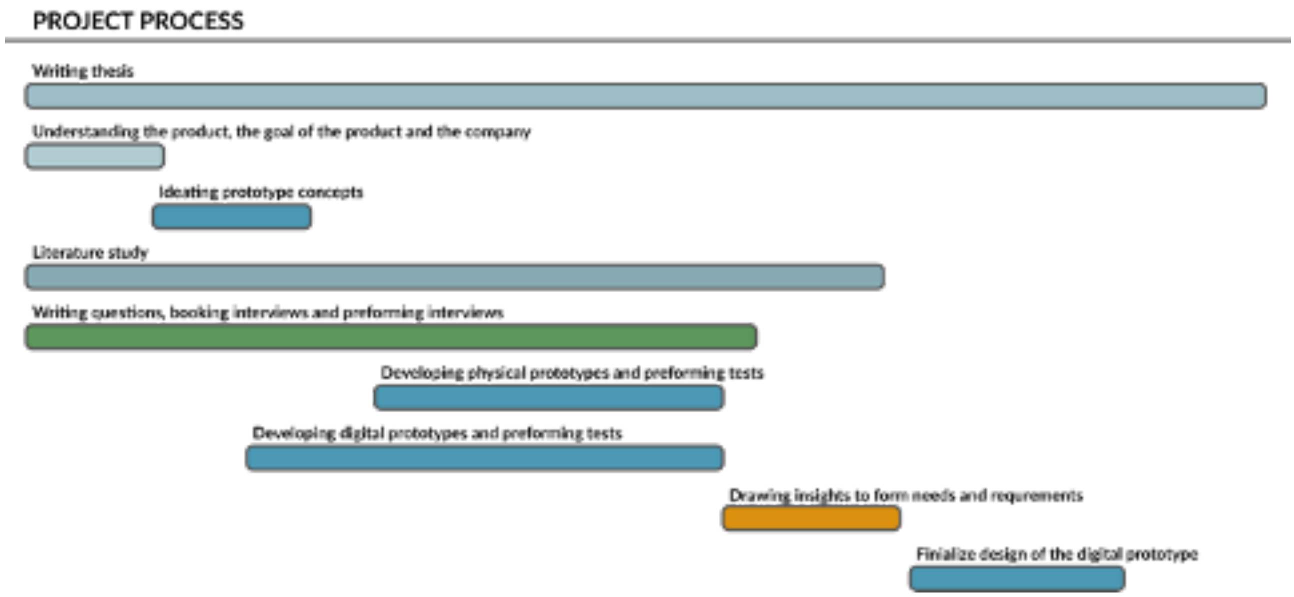
Wikberg Nilsson, Å., Ericson, Å. & Törlind, P. (2015) *Design: process och metod.* Lund: Studentlitteratur

Wölbling A., Krämer K., Buss C. N., Dribbisch K., LoBue P.. & Taherivand A. (2012) *Design Thinking: An Innovative Concept for Developing User-Centered Software.* In: Maedche A., Botzenhardt A., Neer L. (eds) Software for People. Management for Professionals. Berlin: Springer

Yeh, P. C. (2019). *The Influence of the Interface Button Design of Touch Screens on Operation and Interpretation by Elderly and Middle-Aged Adults,* Designs 3, no. 3: 35. https://doi.org/10.3390/designs3030035

Zaman, L., Natapov, D. & Teather, R. (2010). *Touchscreens vs. traditional controllers in handheld gaming.* Future Play 2010: Research, Play, Share - International Academic Conference on the Future of Game Design and Technology. 10.1145/1920778.1920804.

APPENDIX 1 - The Project Process



APPENDIX 2 - Interview Questions, Nurse

Vad är din roll i relation till de som använder TAI?

Hur ser utbildningsförloppet ut?

Hur ser en utbildningssession ut?

Vilka problem ser du oftast med att använda den här typ av teknik?
(Gäller detta både Navina Smart och classic?)

Är användarna, som du ser det, i någon specifik målgrupp?

Hur tror du att en ny och en mer erfaren användares mönster skiljer sig?

Uttrycker användarna något besvär i hur de gör set-upen för produkten? Hur mycket går ni igenom det?

Använder du dig av appen någonting? Kolla på data? Upplever du att användarna använder appen i någon mån?

Återkommer användaren till dig och andra sköterskor när de har frågor?

Vart tycker du att produkten har mest förbättringspotential? Ta gärna upp alla problem du kan komma att tänka på.

Har du något du vill tillägga som du kanske har tänkt på angående produkten?

APPENDIX 3 - Interview Questions, Sales Representative

Vad är din roll i relation till de som använder TAI?

Vad är din roll i till sjuksköterskor?

Hur ser din roll till produkten ut?

Har du fått någon speciell utbildning som behandlar TAI?

Vilka problem ser du oftast med att använda den här typ av teknik?
(Gäller detta både Navina Smart och classic?)

Vilka problem ser du ofta i relation till Navina Smart?

Vilka säljargument använder du när du säljer Navina Smart? Varför ska de välja Navina smart?

Är användarna, som du ser det, i någon specifik målgrupp?

Hur tror du att en ny och en mer erfaren användares mönster skiljer sig till en nybörjare?

Uttrycker användarna eller sjuksköterskorna något besvär i hur de gör set-upen för produkten? Hur mycket går ni igenom det?

Använder du dig av appen någonting?

Upplever du att användarna använder appen i någon mån?

Återkommer användaren till dig och andra sköterskor när de har frågor? Och i så vall vad gäller dessa?

Vart tycker du att produkten har mest förbättringspotential? Ta gärna upp alla problem du kan komma att tänka på.

Om du får fantisera fritt hur hade du velat att produkten fungerade?

Har du något du vill tillägga som du kanske har tänkt på angående produkten?

APPENDIX 4 - Interview Questions, User

Behandlingen

Hur kommer det sig att du använder irrigationsbehandling?

Varför använder du Navina Smart istället för någon annan produkt?

Kan du beskriva din resa från att du måste gå på toaletten till att du är färdig?

Vad är skillnaden på första och andra irrigationen?

Använde du dig tidigare av någon annan TAI produkt? Hur skiljer sig den upplevelsen?

Vilka skillnader upplever du ifrån när du var ny i användandet av produkten till att du har blivit mer erfaren?

Är det någonstans i behandlingen som du har stött på problem?

När du tänker tillbaka på när du var ny i användandet av produkten, var det någonstans du tyckte det var oklart i hur man skulle gå tillväga?

När du skulle utföra behandlingen själv första gången, kände du att det var någon information du saknade? Tyckte du att genomgången hade gett tillräckligt?

Får du ofta felmeddelanden? Vet du vad det brukar bero på? Vad gör du åt det?

Händer det att du kikar i instruktionsboken någon gång? Skulle du vilja kunna hitta samma information någon annanstans?

Förbättringsfrågor

Vad skulle du vilja förbättra med PRIMEING?

Vad skulle du vilja förbättra med UPPBLÅSNING OCH VATTENFLÖDE?

Vad skulle du vilja förbättra med KNAPPARNA PÅ ENHETEN?

Vad skulle du vilja förbättra med MENYN FÖR INSTÄLLNINGAR?

Fysisk

Vad skulle du vilja förbättra med HUR MAN SÄTTER IHOP PRODUKTEN?

Vad skulle du vilja förbättra med hur man PLACERAR OCH HÅLLER I PRODUKTEN?

Vad skulle du vilja förbättra med hur man RENGÖR PRODUKTEN?

Korta datafrågor

Frågorna ställs för att sätta användaren i kontext. Frågorna kommer antagligen inte behövas ställas separat. Svaren kommer troligtvis dyka upp när vi pratar om behandlingen.

Hur länge har du använt dig av produkten?

Hur länge har han använt TAI i allmänhet?

Vilken hastighet kör du vattnet på? Varför?

Vilken ballongstorlek använder du? Varför?

Hur ofta använder du produkten?

Frågor utanför behandlingen

Hur var det att göra set-upen för produkten? (att skriva in namn, medicinsk historik etc)

Vart förvarar du enheten mellan användningarna?

Använder du dig av appen någonting? Kolla på data?

Talar du med någon sjuksköterska eller liknande emellanåt? Känner du att du hade velat det? Varför isf?

APPENDIX 5 - Interview Data

	Function Variation	Years of use	Time per treatment	Placement of unit	Water-container placement	Use frequency	Number of irrigations	Hand function
1	Neck, wheelchair,	5	40min	Table	Table/Stool	Every day	1	Bad
2	Spinal Cord Injury	3	25min	Lap	Table/Stool	Every day	1	Good
3	Anal surgery	2	40min	Hand	Floor	Every other day	1	Good
4	Spinal Cord Injury	1	20min	Around Neck & Hand	Floor	Every day	1	Paralyzed
5	Neurological	1	50min	Lap	Floor	Every day	1	Fine but weaker (bad)
6	Bowel and hand	2	30min	Hand	Table/Stool	Every day	2	Paralyzed
7	Wheelchair and Hand	2	30min	Hand	Wheelchair	Every other day	4	bad
8	Wheelchair	4	40min	Wheelchair	Wheelchair	Every other day	2	Good

	Number of irrigations	Hand function	Water speed	Total water amount	Baloon size	Using the app	Button pressing
1	1	Bad	2	600ml	4	No	Hold to amount
2	1	Good	4	350ml	4	No	Hold to amount
3	1	Good	2	400ml	2	No	Hold to amount
4	1	Paralyzed	2 & 5	600ml	5	No	Hold to amount
5	1	Fine but weaker (bad)	5	600ml	3	No	Hold wait hold
6	2	Paralyzed	1 & 2	900ml	4	Yes	Hold to amount
7	4	bad	1	250ml	1	No	Hold to amount
8	2	Good	5	600ml	5	No	Hold to amount

	Likes	Likes	Dislikes	Dislikes	Dislikes
1	Numbers showing balloon size and water amount	Good for people with lesser hand funciton	Changed unit mutiple times	Difficult ot use buttons with wet hands	Battery looks haft full when fully chanarged
2	Can work as a normal human after use	Easy to use	Unit breaks down	Tubes are too stiff	
3	Life Changeing		Unit breaks down	Takes time to empty baloon	
4	Easy to use		Unit breaks down	Tube connections are difficult to fasten with mouth.	
5	Easy to use		turns off due to inactivity.	Can not continue blowing up balloon after auto stop.	
6	Easy to instruct assistants	Thought the product was great from the start	Unit breaks down	Afraid of breaking the battery	Lacking instructions first time
7	No bowel leakage	Touch buttons	Breaks down	Scary to see it with all tubes etc	
8	Life changeing		Need to wet finger to use buttons		

	Insights	Insights	Insights
1	Do not change settings	Uses 1 water speed	Do not look as screen, looks at water tank.
2	Do not change settings	Uses 1 water speed	The app is not necessary when everything works
3	Do not change settings	Uses 1 water speed	
4	Do not change settings	Uses 2 water speeds	Could have used laminated A4 instructions
5	Do not change settings	Uses 1 water speed	On/OFF button can be difficult ot use
6	Do not change settings	Uses 2 water speeds	Broke down 6 simes first year
7	Do not change settings	Do not want to have push buttons	
8	Do not change settings	Uses 1 water speed	Dips the catheter in water

	Insights	**Insights**	**Problems as new user**	**Quote**
1	Has the unit facing away	Looks at the water conatainer instead of the screen.	No logit in what order to use the buttons.	Difficult to instruct assistants
2	Looks at the screen to see numbers	Demanding for the the mucous membrane to put the catheter in on an angle.	No, used to technology	
3			No, reed the manual	
4	Touch buttons malfunction when cold, wet or dry		no	
5	Did not know that you can change water flow speed.			
6	Much better with digital than manual for assistants.	The buttons are a bit sensitive, the assistants sometimes but wet toilet paper on it.		Saved my life
7				Looks a bit intimidating
8	Personer i rullstol har svårigheter att röra sig.	Navina Smart gives the user control over thir life		I am experienced so I do not use it (regarding the app)

APPENDIX 6 - Digital User Test Instructions

Usability Test for Digital Prototype

Hi, this test is done to evaluate two options for interfaces. It does not test you as a user, it tests how well the interface interacts with you. After using the interface according to instructions you will be asked a number of questions about your experience so please think about how you experience using the prototypes.

Instructions

Start with reading through all the instructions and if there is something you do not understand, ask the evaluation supervisors.

The instructions are the same for both prototypes. Go through the instructions using both the prototypes and answer the questions afterwards.

First irrigation

1. Turn on the unit using the power button.
2. Select treatment
3. Prime the unit using the water button and then press go to treatment.
4. Select water flow speed 4.
5. Inflate the balloon to size 4 using the inflate button.
6. Fill with water to 0.4L using the water button.
7. Deflate the balloon to size 0 using the deflate button.
8. Finish the treatment using the finish button.

Settings

9. Select Irrigate again
10. Choose the following settings:
    - Water flow speed 5.
    - Water amount 0.6L.
    - Balloon size 5.
    - Activate Auto flow mode.

Second irrigation

11. Inflate the balloon to size 5 using the inflate button.
12. Press the auto flow button and let if flow until 0.4L, then press the auto flow button or the water button to stop.
13. Fill with water to 0.6L using the water button.
14. Deflate the balloon to size 0 using the deflate button.
15. Finish the treatment using the finish button.

Review

16. Select finish and review

17. Answer the questions with:
    Treatment satisfaction: **3**
    Feeling of emptiness: **4**
    Bowel movement since last irrigation: **NO**
    Problems in Treatment: **Water leakage** and **Rectal pain**
18. Review your answers
19. Edit treatment satisfaction to **4** and finish treatment.
20. Turn off the unit using the power button.

Questions about the use

1. Did you prefer using the interface with separated water button and inflate- and deflate buttons or the interface that changed depending on which stage in the treatment you where in?

2. Which interface was easiest to understand?

3. Which stage in both the interfaces was most difficult to understand? Why?

4. Was there any wording or symbols that where difficult to understand?

5. Was there any information such as shapes and numbers that could be made easier to interpret?

6. Did the size of the buttons affect how you interacted with the interface. Where they too small, too large or a good size?

7. What need to change in order to make the experience of using the products better in your opinion?

8. Is there anything that is difficult to interpret in this screen?
(regarding the main treatment screen)

APPENDIX 7 - Physical User Test Instructions

Usability Test for Physical Prototype

Hi, this test is done to evaluate two options for interfaces. It does not test you as a user, it tests how well the interface interacts with you. After using the interface according to instructions you will be asked a number of questions about your experience so please think about how you experience using the prototypes.

Instructions

Start with reading through all the instructions and if there is something you do not understand, ask the evaluation supervisors.

The instructions are the same for both prototypes. Go through the instructions using both the prototypes and answer the questions afterwards.

Balloon inflation

On the device you have two gray buttons that indicate more and less air to the balloon. These are the only buttons that are going to be used in the test. The test is measuring precision in blowing up the balloon. There are three target sizes called A, B and C where B is the smallest and C is the largest. Hold the catheter in the size guide to see when to stop.

1. Hold the catheter with one hand and have your other hand on the device.
2. Press the inflate and deflate buttons a couple of times to become comfortable with the actions.
3. Deflate the balloon until there is no air inside it.
4. Blow up the balloon so that it precisely touches the walls of size A only using the inflate button.
5. Ask the evaluation supervisors to measure the size of the balloon using calipers.
6. Deflate the balloon so that it precisely touches the walls of size B only using the deflate button
7. Ask the evaluation supervisors to measure the size of the balloon using calipers.
8. Blow up the balloon so that it precisely touches walls of size C only using the inflate button.
9. Ask the evaluation supervisors to measure the size of the balloon using calipers.
10. Deflate the balloon until there is no air in the balloon.

Water Flow

On the device you will have a big blue button with a water droplet on it. This is the only button that is going to be used for this test. The test is measuring precision in filling a measuring glass with water.

1. Hold the catheter with the tip inside the glass with one hand and have your other hand on the device.
2. Make long and short presses filling the glass with water to get used to the button.
3. Pour out the water from the glass.
4. Fill with water to 20ml, 40ml, 60ml, 80ml and 100ml. and stop at each to make sure that the test supervisor takes notice.

Questions about the use

1. How did you experience using the prototype that had physical buttons?

2. How did you experience using the prototype that had a touch screen?

3. On a scale from 1 to 10, which level of control of the actions did you feel for each prototype?

4. What differences did you experience using the prototypes?

5. What attributes in the prototypes makes them better than the other one?

6. What would you like to change in the prototype with physical buttons to make it easier to use and to give you more control?

7. What would you like to change in the prototype with touch screen to make it easier to use and to give you more control?

APPENDIX 8 - Digital User Test Data

Information
The interfaces are referred to as the "digital" and the "physical" interface altought both are used on a phone.
The users in the tes have different background, some R&D and some with other professions.
The understanding of the treatment while using it is in most cases low with makes it harder to understand.

Summary
Sometimes the physical seem better and sometimes the digital but in general the digital is considered slightly better.
The inflate and deflate button icons were better in the digital version.
The participants had difficulties matchin the name of the buttons in the instructions with the buttons in the interface.
The wording of water flow made it sifficult to interpret as water speed.
The differences in color for active value and settings is both liked and not understood.
Buttons were experiences smaller than the other for both prototypes but are objectively smaller in the physical one.
The interfaces are in general seen as easy to use.
Both interfaces are experienced to have a lot going on at the same time.
Finding, understanding and changeing the settings were most difficult.

Test person	Technical skills	Differenciation	Differenciation
1	4	Thinks the prototypes are similar besides inflate/deflate buttons	Felt no difference in buttons size
2	4	Similarly both were difficult to separate between buttons	Some buttons in the physical version are to small
3	3	The physical was easier to understand	
4	3	Felt like the digital version was easier to understand.	
5	5	Liked the physical one because it had more separation between things	
6	4	Preferred the digital version	
7	4	Likes the symbols for inflate/deflate on the digital one	The digital interface is slighly better
8	3	The digital was slightly better	Unclear inflate/deflate symbols for the physical one
9	5	Physical might feel more intuitive	Likes the digital version more
10	3	Quite similar to each other	Physical buttons were easier to use
11	4	Did not experience any difference	Would have chosen the physical version

Test person	Notes	Notes
1	Difficult to know what button has what name when reading the instructions	Looked for water speed setting in settings where it is not
2	Needed help with matchin instructions to unit	Difficult to make out the buttons from each other.
3	Confused about water speed	Did not understand the meaning of the orange color
4	Though the water level was counting down, not up	Difficult to see with lesser vision
5	Did not like the light blue color indicating water usage	The count down at the end is stressful
6	The wording “modes” is strange	Fast but unprecise usage from the user
7	Thinks both interfaces work great	Likes the differences in color for setting and current value.
8	Unclear when primeing is done	Had no problem with settings
9	Would like more feedback	Difficult to match instruction names to buttons
10	The green check is not intuitive	Some buttons are too small
11	Did not understand where water speed was	

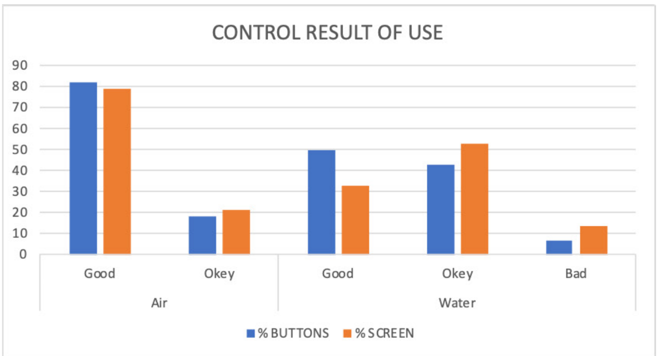
Test person	Notes	Notes
1	Easy to interpret	
2	Doing the settings was most difficult	Wants more “one thing at a time”
3	Likes that it is possible to have a lot of information at once	
4	Difficulties with settings	
5	Difficult to set water amount (small butttons)	Would have liked less buttons at once
6		
7	Likes the movevemt on the screen when irrigating	
8	The green checkmark is interpreted as “approve of settings”	
9	Boring to use	
10	Difficult to understand “modes”	
11		

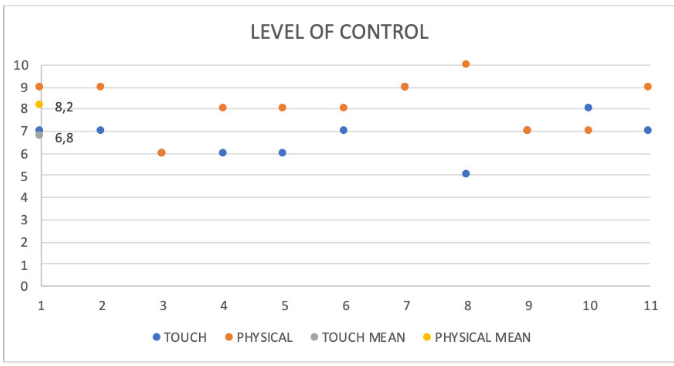
APPENDIX 9 - Physical User Test Data

SUMMARY
The test group experience themselves as having more than average technical skills and a few are familliar with Navina Smart
The touchsreens are resistive touch which a lot of people are not used to.
The test persons level of control is experienced to be higher for physical buttons than digital.
The test persons accuracy in using the prototypes are higher with the physical buttons than the digital.
Physical buttons is experienced as having better feedback than the touchscreen.
When using the digital version the user has to look at the screen in order to make sure he/ she presses the right button.
The touchscreen-version is experienced as more advanced, better looking and having nicer symbols.
The vibration with the touch screen makes the whole unit vibrate not just the area that is pressed.

		% BUTTONS	% SCREEN
Air	Good	82	79
	Okey	18	21
Water	Good	50	33
	Okey	43	53
	Bad	7	14

	LEVEL OF CONTROL
BUTTONS	8.2
SCREEN	6.8





INFORMATION REGARDING GRADEING SCALE	
Water	
The water level is measuered in a measureing glass.	
0	1 ml from the target amount.
1	From 1 ml to 5 ml from the target amount.
2	More than 5 ml from the target amount
AIR	
The balloons closeness to the walls is noted through looking at the closeness from a distance.	
0	Very close to the walls
1	Not very close to the walls
LEVEL OF CONTROL	The user grades their own experience of control from 1 to 10 for each unit.

PHYSICAL

			AIR					
Test person	Technical skills	FIRST	LEG			HAND		
1	4	BUTTONS	1	1	0	1	1	0
2	4	BUTTONS	0	0	0	0	0	0
3	3	SCREEN	1	1	0	0	1	0
4	3	SCREEN	0	1	0	0	1	0
5	5	BUTTONS	1	0	0	0	0	0
6	4	SCREEN	0	0	0	0	1	0
7	4	BUTTONS	0	0	0	0	0	0
8	3	SCREEN	0	0	0	0	0	0
9	5	BUTTONS	0	0	0	0	0	0
10	3	SCREEN	0	0	0	0	1	0
11	4	SCREEN	0	0	0	0	0	0

	WATER									
Test person	LEG					HAND				
1						0	0	1	1	
2	1	1	0	1	0	0	0	1	2	1
3	2	1	1	0	1	1	0	0	0	0
4	1	2	2	1	2	1	2	0	0	0
5	0	1	1	0	0	1	0	0	1	0
6	0	0	0	0	1	0	0	0	0	0
7	1	0	1	0	1	1	1	0	1	0
8	0	0	1	0	1	1	0	1	0	0
9	1	0	1	0	1	0	0	1	1	0
10	2	1	1	0	1	1	0	1	0	0
11	1	1	0	0	1	1	0	1	0	1

DIGITAL

	AIR					
Test person	LEG			HAND		
1	1	2	0	1	1	1
2	0	0	0	0	0	0
3	2	2	0	0	0	1
4	0	0	0	0	0	0
5	0	2	1	0	1	0
6	0	1	0	0	1	0
7	0	0	0	0	0	0
8	1	1	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	1	0	1

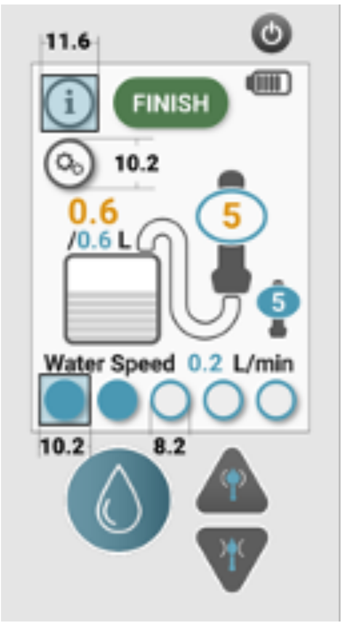
	WATER									
Test person	LEG					HAND				
1	0	1	2	1	0	1	2	1	0	1
2	1	1	2	0	1	2	0	2	1	1
3	2	0	1	0	0	1	0	1	1	0
4	1	0	0	0	2	0	1	1	1	1
5	0	0	1	1	1	1	2	1	1	1
6	1	0	0	0	1	2	2	1	0	1
7	0	0	1	1	1	1	2	2	2	1
8	1	0	1	1	1	0	1	1	2	2
9	0	1	2	0	0	0	1	1	1	1
10	0	1	1	1	1	0	0	1	1	1
11	1	0	0	1	0	1	0	0	1	1

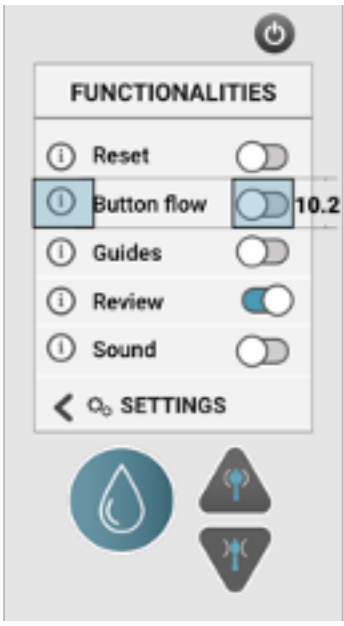
	LEVEL OF CONTROL	
	TOUCH	PHYSICAL
1	7	9
2	7	9
3	6	6
4	6	8
5	6	8
6	7	8
7	9	9
8	5	10
9	7	7
10	8	7
11	7	9
MEAN	6,818182	8,181818
	6.8	8.2

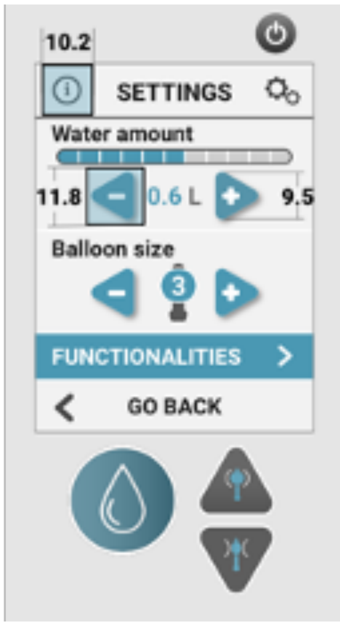
Test person	Regarding Physical Prototype	Regarding Physical Prototype	Regarding Digital Prototype
1	Felt control over the balloon	Felt control over the balloon	Have to look in order to press
2	Distinct press	Distinct press	Became easier after a few tries
3			A bit easier with physical buttons
4	Faster and easier with physical buttons	Faster and easier with physical buttons	The buttons feel cheaper
5	In comparrison to Navina Smart, it is easier to press	In comparrison to Navina Smart, it is easier to press	More control over water flow
6	Felt like physical stoped quicker	Felt like physical stoped quicker	
7	Good feedback from buttons	Good feedback from buttons	Likes the symbols
8	Buttons feel great	Buttons feel great	More similar to how it is right now
9	Likes the physical version	Likes the physical version	Feels like the digital laggs more
10	Will be good for people with lesser hand function.	Will be good for people with lesser hand function.	
11			Feels more advanced

Test person	Regarding Digital Prototype	General	General
1	A bit slower than the buttons	Experienced a faster response with buttons	With the touch buttons there is a learning curve
2	You have look at the screen to use it	Prefer buttons	The whole unit vibrated with touch, would be better if the area vibrated
3	The symbols with the touch unit is better		
4	Vibrates everywhere and not only where it should		
5	Feels like it does not respond every time	Digital prototype looks nicer	Like physical respons, especially because of complaints
6		Feels similar, but a bit easier with physical buttons	Nothing is better with touch-screen
7	Like the vibration	Not very big difference between physical and digital	
8	Feels like it need to be pressed two times	Digital version feels unstable	
9	Can not feel where to push	Wants a smaller version with buttons	
10	Responds faster than physical	Both are better than the current Navinva	It is comforting to hear and feel the click
11	Response is better with screen		

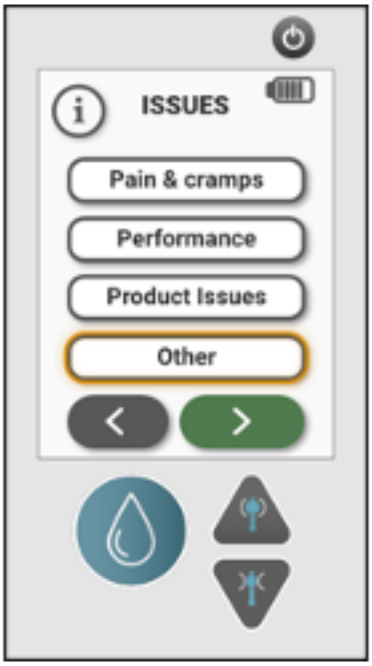
APPENDIX 10 - Pushable area in UI







APPENDIX 11- Using Only Physical Buttons



DEPARTMENT OF INDUSTRIAL AND MATERIALS SCIENCE
DIVISION DESIGN & HUMAN FACTORS
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021
www.chalmers.se