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BACHELOR of SCIENCE THESIS

Development of a Co-Design Methodology that gives Empowerment to People with Various Disabilities

Claudia Westerveld

Abstract

People with either multiple or rare disabilities miss a feeling of cognitive empowerment because they are not able to participate in certain activities. A design methodology, which enables designers and non-designers to produce tools for these users, could prove to be the solution. A case study of one person with cerebral palsy is used to test several methods, such as co-design, when developing these tools. The results of these methods were combined into one design methodology, the Pevadi methodology, that promotes user-inclusion and empowerment. The Pevadi methodology provides structure to the designer in form of a flow-chart. It uses accompanying method cards which give remarks on what to take into consideration when designing to maximise a feeling of empowerment. However, only one case study was used with limited methods so further research needs to be done when using this design methodology for other users.

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1 Introduction

1.1 Problem Statement

A study of the Dutch population determined that 11.0% of the inhabitants suffer from mental illnesses while 29.2% has a physical disability that limits them in activities that able-bodied people can do [1]. The number of people with disabilities over the world compared to the Netherlands is even considerably larger. This is due to the risk of disabilities in low-income countries being higher [2].

The amount of disabled people is quite high, but the kind of disability one may have could be difficult to diagnose. A study done by G. Silibello et al. recruited 154 patients with rare disabilities, 12.9% had no specific diagnosis [3]. These people with rare disabilities, like cognitive and behavioural impairments, are also excluded by employers. They have notions of incompetence, social inadequacy and extensive needs about disabled people [4].

It is important that people with strange or rare disabilities get the opportunity to receive special care, help with employment and receive tools that enables participation in more activities which lets them feel empowered. According to the 'Convention on the Rights of Persons with Disabilities' made by the United Nations [5] which upholds countries to enforce it, it is even mandatory. It states that everyone should have equal opportunities and equal access. While there are tools available for people suffering from disabilities, they have to make do with what is available. A design methodology that enables designers and non-designers to make tools with less effort, while including users with disabilities to see what they want, is missing.

Figure 1.1: It aventoer

1.2 Case Study

It Aventoer [6] shown in Figure 1.1 is a facility in the Netherlands which aims for the previously mentioned equal opportunities and access [5]. It is a small-scale company situated on a farm that offers 24-hour day-care, organises daytime activities and offers the possibility of permanent housing to people with special needs and disabilities. This permanent housing endeavours to instil some self-reliance to these people while being in a safe environment in which help is given if needed. It Aventoer also offers these people to work simple jobs on the farm or in the shop 'Winkel fan Tryn' [7] so they can acquire experience. However, a few residents still need personal solutions because they cannot do certain tasks themselves which has a bad influence on their confidence.

Figure 1.2: Sanne

Sanne as seen in Figure 1.2 is such a resident and cannot do demanding tasks that requires her legs or hands because she is bound to a wheelchair, has limited strength and limited motor control. Although she loves working on a farm, it is difficult for her to do tasks like feeding the animals, raking leaves or other tasks because of this. It Aventoer has already altered her wheelchair so it can attach to a cart that makes her able to drive cargo to other parts of the farm. However, caregivers still have to attach this cart and Sanne must wait for other residents to fill up her cart which results in a feeling of uselessness.

Inventions like the wheelchair or white cane already exist to help a multitude of disabled people like Sanne. However, facilities like It Aventoer are looking more for specialised solutions to give the residents a feeling of empowerment. While they have volunteers who sometimes try to build special tools or devices for the residents, they do not always have the time or resources. Many tools already exist that assist able-bodied people to help disabled people. For example, Movicloud [8] or the educative game 'The kingdom of Fonemas' [9], but there is not really a standard design methodology which promotes cognitive empowerment or includes the user during the whole process. It Aventoer would benefit from such a design methodology that could lessen the stress of time and simplifies the process.

1.3 Objective and Challenges

The specific objective of this bachelor thesis is to develop a design methodology for designers and non-designers that can be used to make specialised tools that empower a person not only in a functional but also in a cognitive manner. Additionally, co-design is a way to get users more involved in the design process but has not been tested a lot with users like Sanne. That is why the challenge is to try co-design with this target group to observe if it has added benefit in the design methodology when incorporated. Lastly, the case study of Sanne is utilised to develop a design methodology and a specialised tool for Sanne will be produced. This tool will allow Sanne to attach a cart to her wheelchair and lock it into place so she can move cargo around It Aventoer.

1.4 Research Questions

The following main research question has been developed in addition to a set of subquestions.

How can a co-design methodology be developed to make specialised tools that empower a person with mental and physical disabilities in daily activities?

The partial questions that will be dealt with along the way are:

1. What is empowerment and what elements of design could help with empowering users?

2. What are existing tools for people with disabilities missing to increase a feeling of empowerment?

3. What methods in co-design work or need to be adjusted to be effective with this target group?

1.5 Structure of this Paper

First of all, the methodologies and methods used will be explained to the reader. Then related work research into Sanne her disability, empowerment and the different kind of existing tools is done. The case study of Sanne is divided into three different phases, namely ideation, specification and realisation, which will be chronologically followed. After each phase a summary of the progress of the product and the methodology is given and in the realisation phase the final results are presented. At last, a discussion will be held which results in a conclusion and possible future work suggestions.

2 Methodology

The methodology that was an inspiration for the new design methodology for specialised tools is explained in the following paragraphs. The 'Creative Technology' method developed by Mader and Eggink [10] which can be seen in Figure 2.1 will be utilised and enhanced to fit the specific target group. Additionally, co-design will be extensively explained and used for this research question. Lastly, the methods that are used during this research will be explained and their results will be given in sections 4, 5 and 6.

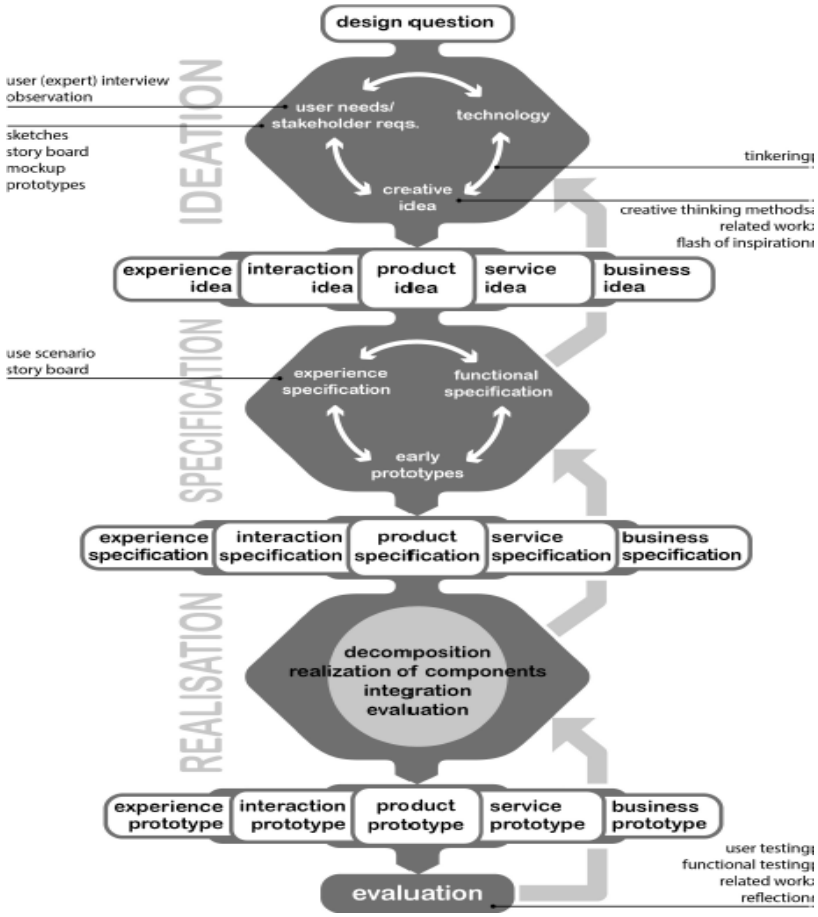


Figure 2.1: The Design Process of Creative Technology

2.1 Creative Technology Method

This method as seen in Figure 2.1 consists of four phases on the highest level; Ideation, Specification, Realisation and Evaluation. It is important to note that each phase begins and ends with a determined set of results which must be achieved before continuing with the next phase. This is built on a classical model already described by Jones [11] which is a creative design process consisting of a divergence phase which is followed by a converging phase. In addition, the Spiral Model developed by Boehm [12] was an inspiration and is reflected within each of the phases of Ideation and Specification.

The intention of this method is that during each phase you diverge your ideas and use your creativity to achieve multiple ideas, specifications or prototypes. The results of the phases then need to be compared so the user of the method can converge them and continue with the next phase. This combination of divergence and convergence with a cyclic concept results in an overall trajectory in more comprehensible units than a global divergence-convergence approach or an overall cyclic model [10].

This method will be the basis of the methodology that will be developed for the user group of people with mental and physical disabilities. The Creative Technology method is already extensively used by students of the University of Twente and is a combination of two solid existing processes. In addition, the method is easy to follow and does not include procedures which non-designers would not be able to do. As such, the writer of this paper thinks it is an excellent basis for a new design process with a specific user group.

2.2 Co-design

During co-design sessions there is a focus on the act of making. Sanders and Stappers define making as ‘a performative act of reproduction, but a creative act which involves construction and transformation of meaning, by any or all people’ [13]. They explain that making is a significant activity in the design process because people can show their insights in real life.

Sanders and Stappers [14] made a comparison of three approaches to making. First,

you have probes which are tools, materials or objects especially made to elicit a response from the user group. They are send to stakeholders and designers can use their reactions to inspire them. Secondly, you have toolkits which consist of a multitude of different objects which are given to non-designers so they can physically visualise their ideas. Finally, you have prototypes which are made by designers and given to stakeholders so they can receive feedback. These methods are the most common ways of applying co-design. The author will utilise toolkits and prototypes to test if co-design is a helpful tool during the design process with this target group. In section 3.3 a more extensive explanation is given about co-design and its history.

2.3 Methods

Standard techniques and already existing frameworks were used to analyse if they worked for this specific target group. The focus lies on qualitative methodology because there is only one case and it is a very small target group. Qualitative methodology is used to understand people from their own frame of reference [15].

The following paragraphs will be used to describe all used methods and give an explanation on what they do. The sections 4, 5 and 6 will show the results of the usage of these methods.

2.3.1 Related Work

A literature review was conducted by the author to establish important factors which are important for the development of a new design process. For example, if a user needs to be empowered the designer/researcher needs to know what it exactly entails and which definitions exist. Research was conducted in related work to see what the disability of Sanne entails, how co-design is used, what empowerment is and what kind of tools are already developed for people with disabilities.

2.3.2 Interviews

A series of interviews will be conducted with not only the user, but also interviews with people working in the healthcare section. Different kinds of interviews exist and some of them will be utilised and tested to see if they are applicable to this user group.

Structured Interviews are interviews with a pre-defined set of questions and in a pre-defined order. The interviewer is not allowed to deviate from this schedule or allowed to probe further on certain topics. They are easy to replicate and fairly quick but any impromptu questions the interviewer might have is not allowed. The questions are also closed-ended questions meaning there is a set of answers the interviewee may choose from [16].

Unstructured Interviews are different from a structured interview because there are no pre-defined questions or order to the questions and all of them are open-ended. This means that the interviewee must come up with their own answer. The interviewer comes up with questions on the spot which results in a quite flexible interview. Unfortunately, such interviews can be quite time consuming to analyse the date and the duration of such an interview is usually longer[16].

Semi-structured Interviews are a combination of the two previous methods. The interviewer has a pre-determined set of themes to discuss and is allowed to bring up new questions during the interview. These semi-structured interviews are very flexible while also following a set of themes so the interview does not deviate from the subject too much. Nonetheless, it still is time consuming to analyse its data[16].

2.3.3 Observations

Observations are a suitable way to analyse behaviour of the user. Taylor et. al [17] states that making observations is the only method where the depth of understanding is the greatest just by observing people and listening to what they have to say at the scene. The author of this paper will observe several days on It Aventoer.

2.3.4 Prototypes

Prototypes are divided into three categories: 'Physical-tangible, analytic-virtual and experiential-behavioural' [18]. This paper focuses on physical-tangible prototypes because they are simple physical representations of ideas produced. They also provide a suitable medium to represent functional requirements in a physical form which fosters divergent thinking about the problem and the solution [18], [19].

2.3.5 Scenario-based Design

Scenario-based design uses 'scenarios' which describe activities done by humans to achieve goals in the format of pictures or words [20]. They allow design activities to become more accessible towards stakeholders whom can contribute to the design [20] and allow questions and insight by stakeholders about problematical points contained in scenarios which leads to a deeper understanding [21].

2.3.6 Expert Interview

An expert is somebody who is assumed to have expertise knowledge in a subject that the interviewee or other people do not possess. Interviews are conducted with experts in certain subjects, depending on what data you need to gather. It is more efficient and the researcher is able to gather more data in a short period of time, especially when the expert and the researcher share a similar background [22].

2.3.7 Frameworks

A multitude of frameworks already exist to aid researchers and designers. A couple of them were utilised during this case study to analyse certain situations.

PACT-analysis This is a framework that can be used for design activities to better understand and obtain a good analysis of the current situation. You have four categories which are People, Activities, Context and Technologies and the designer uses methods like interviews, observations or sketches to scope them [23].

MoSCoW The MoSCoW framework is a method that analyses and divides requirements in four different categories. These categories are *Must Have, Should Have, Could Have* and *Won't Have*. Designers initially aim to achieve all the requirements in the first three categories. If the timeframe of the project is too short, designers can remove requirements from the *Should Have* and *Could Have* category first. All the categories are described below in Figure 2.2 according to 'A Guide to the Business Analysis Body of Knowledge' [24]. Additionally, an example of a standard MoSCoW analysis is given in Figure 2.3.

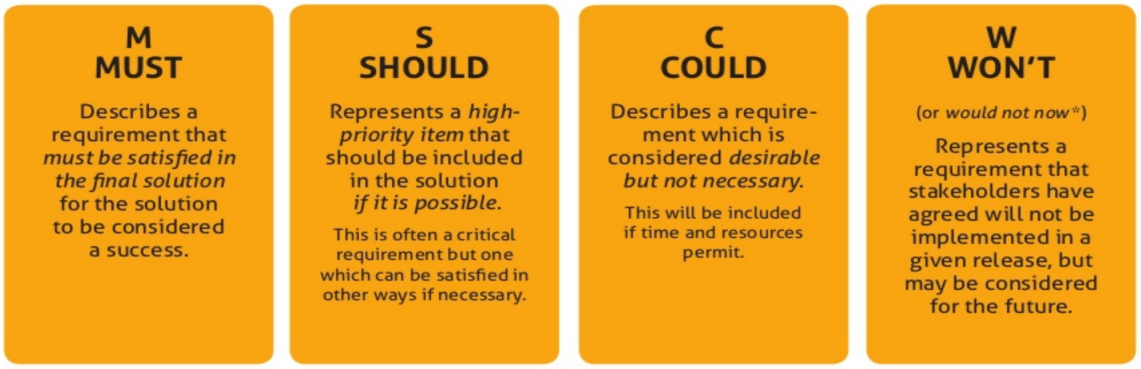


Figure 2.2: MoSCoW analysis [25]

Figure 2.3: MoSCoW example [26]

3 State of the Art

In the following section a look will be taken at the specific medical condition that plagues Sanne. Secondly, the definition of empowerment and how it can be achieved for people with disabilities will be discussed. Co-design its history is given and how this method can contribute in a design process. Additionally, all the current research into tools designed to help people with various disabilities will be discussed and this section will end with a statement about why this research is novel.

3.1 Disability of Sanne

Sanne has a specific disability which is called 'infantiele spastische tetraplegie' which is Dutch for 'infantile spastic quadriplegia'. This condition is a subset of cerebral palsy and Denhoff [27] states in his book that people with cerebral palsy show characteristics of:

'paralysis, weakness, incoordination, or any other aberration of motor function due to malfunction of the motor centres of the brain. He/she may also have other symptoms which reflect a damaged brain... There may be convulsions, mental retardation or deficiency, vision, hearing or perceptual problems, as well as speech, behavioural and emotional disturbances.'

Bax [28] states that cerebral palsy is caused due to a lesion or defect of the immature brain. Additionally, Rosenbaum et al, [29] made a report on cerebral palsy where they looked at previous literature to come up with the specific definition of cerebral palsy. This resulted in the following definition:

'Cerebral palsy describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain...'

Thus, cerebral palsy has multiple classifications of which 'infantile spastic quadriplegia' is one of them. Spastic quadriplegia means that Sanne suffers from spastic contractions of

the muscles in four of her extremities, the arms and legs [30]. Sanne is in a wheelchair and cannot move her legs but she has limited control over her arms, especially her right arm. She also suffers from limited control of her mouth muscles which sometimes causes speaking to be difficult. Finally, her mental capabilities are, according to caregivers of It Aventoer, similar to those of a ten year old child. This is probably due to a disturbance during the development of the fetal brain.

3.2 Empowerment

It is important to keep the capabilities of people with disabilities, from now on called users, in mind when a design is made. Designs developed for able-bodied people are sometimes not suitable for people who suffer from illnesses or handicaps. These designs can cause emotional distress if it turns out they are unable to use them. In this section an explanation will be given why and how we can empower people with disabilities.

3.2.1 What is empowerment?

The lexical definition of empowerment is determined as follows: "Give someone the authority or power to do something (functional empowerment); Make someone stronger and more confident, especially in controlling their life and claiming their rights (cognitive empowerment)" [31]. Tools that are developed for people with disabilities mainly focus on the functional aspect of empowerment so they can perform more activities. A study done by Mokdad et al. [32] about wheelchair users concluded that negative emotions attached to the wheelchair are the strongest even though the wheelchair gives them the ability to move and participate in more social activities. The wheelchair was specifically developed to empower users in the sense that they can perform more activities. However, the results of Mokdad et al. give away that empowerment in the sense of making someone more confident lacks in the wheelchair because it reminds them of their disability. This fact is crucial because it means that when developing tools to empower users, both definitions of the word must be considered. Otherwise, you get tools that allow users to perform more tasks but gives

them a sense of disempowerment.

3.2.2 How can empowerment be achieved?

Thus, empowerment in its totality needs to be considered when developing devices or tools for people with unique disabilities. Unfortunately, there is not a specific road map on how to achieve this sense of empowerment but some researchers have gotten results that let users feel empowered. Cumming et al. [33] conducted a study where researchers with intellectual disabilities were given iPads to help with research skill acquisition in their professional lives and give them a feeling of empowerment in their personal lives. They saw that it empowered the researchers in their personal lives because it helped them to initiate conversations with others, prolong these conversations and it allowed some to be the experts because they could show others how iPads work.

Although the possession of these iPads could help with empowerment, it also caused some researchers to feel disempowered. One researcher had staff that borrowed the device without asking for permission and another researcher had her iPad taken from her by family members because they thought the photos on the iPad were inappropriate. These events are important because it shows that making their own decisions is an important tool when empowering people with disabilities.

One researcher decided that the iPad was not suitable for her which is a sign of empowered behaviour. Cumming et al. [33] state that part of having a say in such a decision that affects a person's right is the ability to say 'no' to people violating this right. Martin [34] argues that empowerment is 'having a real say in decisions that affect our lives. Empowerment is not something you suddenly have one day'. It takes time to learn how make your own decisions and results in empowerment.

Löve et al. [35] performed qualitative interviews with leaders of activist groups and disability organisations in Iceland. Some of these leaders expressed discontent with their appointed representatives, who are often non-disabled, in the Icelandic politics because they felt that decisions had at times already been made before the meetings with the authorities

were convened. In addition, they told Löve et al. that they must be vigilant to ensure that their opinions expressed by the representative were actually included in the meetings. However, the group meetings of the activist groups themselves provided members with a platform to voice their opinions and issues they had. The members reported feeling empowered and one person associated with the group said that "the needs of disabled people have until now traditionally been left to 'experts' to define. Now, disabled people are defining the issues themselves. This gives voice to people who are not used to having a voice." This confirms the notion that decision-making and voicing your own opinion is a big part in giving empowerment to people with disabilities.

Darcy et al.[36] conducted research to see how disabled people used mobile technology, what modifications were needed and to determine if there were any influences on the use of mobile phone technology. Results showed that the participants of the study exhibited signs of increased empowerment, self-confidence and self-determination by using a range of communication apps. However, Darcy et al. also concluded that significant others their involvement is central. Some actively discouraged the use of mobile phones and this resulted in discontinuance in the usage of the phone while it could have increased their empowerment if used. Additionally, some users stopped using the phone because the modifications made were not extensive enough and using it was too difficult either physically or mentally.

Van Dijk et al. [37] state that active involvement during the design process is invaluable to create meaningful outcomes. This means that is it practically impossible to not involve the user if you want to let the user take control of their life. In other words, deciding on how to deal with the practicalities of one's own life during the design could empower the user just as much as providing the tool that would result from the design.

In summary, to increase self-confidence and thus create the feeling of empowerment that some people with disabilities miss, the focus must lie on decision-making and the feeling that users can do it by themselves. Having a real say in a decision that affects your life results in a feeling of empowerment [33], [34] and people with disabilities should voice their own opinions [33]–[35]. A given opinion during the design process of a tool that could resolve

problems of the user, empowers them just as much as the empowerment the tool itself would give [37]. Lastly, it is important that significant others, family or fellow staff members are properly informed because their involvement can result in a feeling of discouragement or disempowerment although they mean well [33], [36].

3.3 Co-design

It is vital that before testing and implementing co-design methods, a sense of the background of co-design and its history is acquired. First, the act of co-design and what it entails will be clarified. Secondly, an explanation will be given why co-design is so important for not only designers but also the users.

3.3.1 What is co-design?

The term co-design is a specific instance of co-creation. Sanders and Stappers take co-creation to refer to any act of collective creativity which entails that creativity is shared by two or more people. They state that this practice of collective creativity has been around for almost fifty years but was going under the name of 'participatory design' [13]. Although there is a fine line between co-design and participatory design the author will always refer to co-design.

Nowadays, co-design is defined as a collective creativity as it is applied across the whole span of a design process [13]. This means that co-design is not only an act of collective creativity but rather refers to a collective creativity between designers and non-designers working together during the whole development of the design process. It is a new way for designers and potential users to collaborate and enables new ways of performing creative actions and participating in design and production [38].

This means that the roles of designer, user and researcher become mingled and interwoven according to Stappers and Visser [39]. Sanders and Stappers find that [13]:

'In co-design, on the other hand, the roles get mixed up: the person who will eventually be served through the design process is given the position of "expert of his/her experience",

and plays a large role in knowledge development, idea generation and concept development. In generating insights, the researcher supports the 'expert of his/her experience' by providing tools for ideation and expression. The designer and the researcher collaborate on the tools for ideation because design skills are very important in the development of the tools.'

In conclusion, co-designing requires that that all stakeholders like researchers, users or designers show creative initiative and work together during the design process to help assist the development of tools or devices. Co-designing requires preparation by the designer and/or researcher to guide the users during sessions. It is almost impossible to include the users during the whole design process because of time restrictions, lack of knowledge in engineering or other aspects. That is why, especially during the ideation and specification phase, designers invite users and researchers to participate in co-design sessions.

3.3.2 Why is co-design important?

Stappers and Visser concluded that participatory design techniques are becoming increasingly important elements in the development of a new product design [39]. This conclusion can also be applied to co-design because it was often referred to as 'participatory design' in the past. Furthermore, co-design focuses, as determined in section 2.2, on the act of making. Making is for designers a very particular significant activity because non-designers can bring their insights to the surface [14]. Co-design is becoming increasingly more important in the world of designers because it can bring together designers and non-designers. This is why co-design will also be utilised for a new design methodology.

3.4 Tools developed for disabilities

As mentioned in section 1, the amount of people with disabilities is enormous but the severity of the disability varies per person. For example, missing a finger can limit your activities but probably not as much as someone who has a visual/hearing impairment or a mental disability. Fortunately, for disabilities which are widely known there are solutions

which resolve the problems such an impairment can give. We have glasses, hearing aids, wheelchairs and the white cane which caters to a lot of these issues that arise with having a disability.

However, the number of specialised tools or devices for specific cases leaves a lot to be desired. Although they do exist, there are so many people with such a specific case that it is difficult to cater to their needs. Researchers are trying their best to develop more specialised tools which can satisfy multiple disabilities at once or help designers to think about disabled people. Research into the literature gave away that there are three categories of tools being developed which are discussed in the sections below.

3.4.1 Tools focusing on giving disabled people more access

For example, A.Burrioso et al. developed a tool called Movicloud [8] which could render a 3D-model of the working environment and produce simulations. This allows designers or companies to see which problems workers with disabilities face so the working environment can be adjusted. However, the problem that this tool resolves is not meant for users with disabilities, but more for able-bodied people. Movicloud does not give any empowerment to people with disabilities but rather gives the employer the means to adjust the working environment to give easy access to users. While this might empower users because they can perform more activities in the working place, Movicloud only focuses on easy access to an office environment. It does not provide a way to analyse if more tasks could be given to disabled employees with specific disabilities.

Additionally, multiple studies were conducted with the same reasoning as Movicloud. Shinohara et al. [40] refined 'Design for Social Accessibility' so designers would include disabled people as well as able-bodied for already existing tools/environments. Furthermore, Darcy and Pegg argue that managers of hotels should create enabling accommodation environments to include the disabled [41].

3.4.2 Tools that assist the able-bodied in helping people with disabilities

An interview was conducted with H. Kuipers and M. de Boer who work for Patyna [42]. Patyna is a health care organisation focused on the care of elderly people and aims to help them live at home, rehabilitate or provide a living space with care if they cannot live at home anymore due to disabilities. They are utilising necklaces with a button that are worn by the inhabitants of facilities of Patyna. The button can be pressed so the nurses know that they are needed for immediate assistance. Although this necklace is also meant to assist the inhabitants, its focus is to alleviate stress of the attendants so they do not have to check up on inhabitants as often.

Their next goal is to utilise sensors in the rooms of inhabitants so they know when they get out of bed or if they have eaten yet. Although these are working on smart environments, which could reduce the number of incidents like falling out of bed, this technology is used to reduce the stress of nurses. Herman and Meindert stated that in the Netherlands in twenty years there is a huge shortage of nurses so technology needs to be developed to reduce their stress and the focus on empowerment for the elderly is not as important. They want to provide safe environments first which is understandable.

The game 'The kingdom of Fonemas' [9] is an educational game developed by Y. Rybarczyk which supports the reading learning process in children with developmental disorders. Although this game can empower children because they learn how to pronounce words better, the tool is not specifically developed to help them but to assist the therapist. The game shows the patient's progress and shows the main difficulties of the user to the therapist.

3.4.3 Tools that help people with disabilities in everyday tasks

Pathak et al. [43] performed a study with subjects suffering from Essential Tremor which causes upper limb action tremors that interfere with regular tasks such as eating. They developed and tested a handheld device, in this case a spoon, which uses Active Cancellation of Tremor technology. This technology senses when the user its hands are trembling and generates a movement in the opposite direction to cancel the tremor. The result was a

significant decrease in tremors and gave the subjects the ability to eat on their own without other more invasive methods. Riviere and Thakor [44] got the same results when testing this technology with users who do not have good motor-control. They were able to utilise computer mouses using the active cancellation technology.

Bousseta et al. [45] developed a brain computer interface for a robot arm which could sense neuronal electrical activities from the subjects and enabled them to control the arm in four directions. This arm assisted them in helping them find and grab objects. Their accuracy was on average 85% so it should still be improved. Qu et al. [46] enhanced an existing brain computer interface that uses an image of letters and p300 signals from the brain so people who cannot talk can still use their eyes to spell words. They adjusted the image of letters so it was three-dimensional instead of two-dimensional and saw an improved accuracy and reduced workload of the users.

3.4.4 Summary

The conclusion that can be taken from these papers is that a great deal of research has been done to include the disabled in certain environments or during the design process. A few papers [8], [40], [41] target able-bodied people so they can accommodate for people with disabilities. They also focus on functional empowerment in the sense that they can perform more activities. Tools like the necklace from Patyna, certain smart environments of Patyna [42] and the 'Kingdom of Fonemas' [9] are developed to assist able-bodied in helping people with disabilities or impairments. The core of these technologies is helping able-bodied to care for disabled people which is not wrong but it lacks in giving cognitive empowerment. Also, technology is improving at a rapid rate and is assisting many people with disabilities and impairments doing everyday tasks [43]–[46]. However, the writer of this paper could not find any research that was done for specific tasks like a job at a farm which is what Sanne wants.

3.5 Novelty of this Thesis

Increasing self-confidence and thus creating the feeling of empowerment that some people with disabilities miss is very important. The focus must lie on decision-making and the feeling that users can do it by themselves. Involving the users during the design process promotes empowerment just as much as the tools that are made. Furthermore, current tools and technologies being developed do not focus on the cognitive empowerment of people with disabilities or on specific tasks. But more on helping able-bodied adapt to people with disabilities or to decrease the struggles of everyday life tasks. This leaves a gap in research and thus in the design methodology. There is no existing design methodology on how to develop these specialised tools for people with physical and mental disabilities. This paper can shed some light on a design methodology that is suitable for people with various disabilities that involves the user in the design process and promotes functional and cognitive empowerment. Additionally, this design methodology could be used by either designers or non-designers.

4 Ideation

In this section the focus is on gathering all relevant information to acquire a general idea for a product. Several design methods from section 2 are used during the Ideation Phase and will be discussed and highlighted.

4.1 Research into Related Work

Related work was conducted and deemed pretty successful to gain an insight on the specific disability of the user as described in section 3.1. It was also useful to see how you can empower such a user in not only a functional manner, but also in a cognitive sense which was mentioned in section 3.2. Research was also done to see if this specific design method developed for people with mental and physical disabilities is novel which can be read in 3.5, but is not relevant for future users of this design method because it has already been proven with this paper.

Research into related work is necessary for every research paper to determine if the research into that specific topic is novel and will contribute to the development of a certain science. However, during a design method related work for novelty is somewhat useless because the designer is not developing for a science but rather for a stakeholder. Nevertheless, related work into the disease of the user and how to achieve a feeling of empowerment showed to be really useful because the writer of this paper did not know the disability of Sanne or how you could empower such a user. If a designer is working with such a specific user it is necessary to know what the effects are of their disabilities so the right considerations are made during the design. That is why related work research will be included in the design method being developed. However, because non-designers do not really know what related work is, it will be called 'online search' so they know they need to find information online.

4.2 Observations

The author of this paper spent several days on It Aventoer observing and watching Sanne while she performed tasks on the farm or performed other miscellaneous activities. These observations gave a huge insight on the life of Sanne and the struggles she has to deal with daily. These observations where analysed and summarised into a PACT-analysis [23] which can be seen in table 4.1.

The observation that made the heaviest impact was to see Sanne performing tasks while she had to wait for others. For example, when she needed to feed the chickens she has to grab grain with a scoop from a bag and pour it into food holders for the chickens. Unfortunately, she has to wait for caregivers or other residents of It Aventoer to grab the food holders and a bag of grain and put it onto a table. The look she has on her face when waiting is one of boredom and disappointment. Sanne herself told the author the waiting was 'stom' or stupid in English.

People	**Activities**	**Context**	**Technologies**
Physical limitations such as a wheelchair, limited motor control of arms, slurred speech and spasms	Daily tasks on the farm	Outdoors and indoors activities because it is a farm	Electric wheelchair with input by buttons and joystick
Mental limitations as lower IQ and EQ	Most tasks performed by Sanne require actions from others before she can continue	It could be sunny, raining or snowing	Wheelchair can move forwards, backwards, to the left, to the right, tilt forward, tilt backward, go up and go down
Easily stressed	Tasks have no manual but caregivers help when needed	Caregivers are always present during the performance of tasks	Has a smartphone but cannot use it easily due to limited motor control
Novice user of technology	If a mistake is made it could harm people or animals but the risk is low	Activities could be performed during every timeslot of the day except for night	

Table 4.1: PACT-analysis of observations

4.3 Interview Patyna

As mentioned in paragraph 3.4.2 an semi-structured interview was conducted with employees of Patyna [42] and they also gave some insights on designing for people suffering from mental and physical disabilities. The questions that were prepared can be found in Appendix C. Both employees work on developing tools and technology for elderly people living in a residency home to assist them in living more independently.

Their personal experience gave away that they built a lot of prototypes and have several iterations of testing to ensure that their products are safe to use. However, when asked about considering including users in their design they showed doubt. They mentioned that the amount of people available in healthcare in the Netherlands is reducing at a rapid rate. Their preferred method is to design tools that will not only help the residents but most of all reduce the stress on the staff.

Ansah et al. [47] also confirmed that this is not only the case in the Netherlands. They state that many countries experience workforce shortages in the healthcare sector. This means the main focus is on tools that could help a multitude of people which is also the case at Patyna. They state that they do have specific cases but try to implement it for people with different disabilities.

The conclusion of this interview was that general tools are as of now more important but do result in a feeling of social isolation and feelings of resentment. The replacement of staff and nurses into technology means that some elderly have less social contact and thus experience social isolation. The technology or tools could also remind them of their disability like the people in the study of Silibello et al.[3] which results in resentment.

Patyna would like to design for specific cases but simply has no time to do so with the impending shortage of nurses. A simple design method would be a solution to reduce the amount of prototypes and testing they are currently doing. They suggested that a method which could pinpoint the specific problem in an easy way that would reduce the amount of testing would be ideal.

Additionally, interviews with Sanne were also conducted but deemed to be less useful.

All three kinds of interviews did not prompt Sanne to give her un-biased opinion. She would often doubt what she thought and state that she did not really know. However, when she performed tasks during observations and got questions about those, she was able to answer. Thus, interviews are ineffective but designers should ask questions when users are busy with another task.

4.4 Co-design Using a Toolkit

The method used during the first session of co-design was providing a toolkit which is explained in 2.2. A co-design session with a toolkit usually consists of the designer/researcher and a small group of stakeholders. A co-design session with a toolkit differs in length and in application which was also the case for this co-design session. Staff from It Aventoer were informed about co-design and the toolkits and gave suggestions on what would work best for the target group. In Appendix A the structure of the session is shown while in the following paragraphs the session is discussed. A short conclusion is given at the end to summarise why co-design with a toolkit is useful for this target group.

4.4.1 Introduction

The session started with six participants including the author of this article and Sanne. In addition, two other residents of It Aventoer were present, one caregiver and one intern. Although another caregiver was present, she was busy attending the store 'De winkel fan Tryn [7]' and sometimes gave feedback but was not actually included in the co-design session. The present caregiver consulted with the author about the residents and the characteristics of the participants to optimise the session. For example, the sessions of using the toolkit were limited in time because residents usually have a short attention span.

The consent form as seen in Appendix B was explained to the participants upon which they all agreed to participate in the co-design session. The author concluded that regular consent form use words that are too difficult for the residents, even though the consent form was in their native language. Also, users do not really realise the consequences of agreeing

Figure 4.1: Impression

to those. It is advised that for future sessions the designer writes the consent form in the native language of the resident with easier words. Lastly, they should ask caregivers if it is easy to understand for the residents.

The author explained extensively to the participants that everything was allowed during the session in accordance to advice of the supervisor of this paper. This was deemed a necessity eventually because the participants never had co-designed before and thought they were limited in their ideas. However, once the author gave examples of other co-design sessions they understood that they could create and utilise all materials and not be limited in their creativity.

4.4.2 Brainstorm

The first part of the co-design was a brainstorm session as can be seen in Figure 4.1 and was more for the designer to better understand and grasp the sheer amount of activities that are organised for the residents. Additionally, it had the positive side-effect that the participants could discuss on the activities mentioned to decide which activity to co-design for. The secret goal of this brainstorm was to see what Sanne her preferred activity would be because she found it very difficult to voice her opinion to the author during observations and interviews.

Everyone received sticky notes and pens and were told to write down all the activities

they could think of. A mention was given that all the activities were allowed, especially activities that Sanne could not do at the moment. The residents who could not write got help from either the author, intern or caregiver. The notes were put on an A3 paper and all the tasks were briefly discussed. All participants came to a conclusion that feeding the chickens was a good activity to design for and Sanne herself chose a mechanism so she could attach/detach a cart to her wheelchair on her own.

(a) Design 1 (b) Design 2 (c) Design 3

Figure 4.2: The three designs of the co-design session on how to feed chickens

4.4.3 Toolkit Sessions

This part consisted of two sessions of ten minutes to utilise the toolkit provided to design tools for Sanne. The group was paired up because people with physical disabilities were unable to use all the material given and some found it difficult to begin but with help from either the intern, caregiver or author it went smoothly. The residents first observed but when they saw how it was done they actively participated and came up with ideas of their own. The author assisted one of the residents but also observed the session to see how they experienced it. Furthermore, the whole session was on camera so the author could review the session afterwards.

The first session was about feeding the chickens and the results are shown in Figure 4.2. The second session was to think of a way that allowed Sanne to attach/detach a cart to her

(a) Design 1

(b) Design 2

(c) Design 3

Figure 4.3: The three designs of the co-design session on how to attach/detach cart

wheelchair on her own and the results are shown in Figure 4.3.

The end result as shown in Figure 4.2 and 4.3 are very low prototypes. However, they give insight on how the stakeholders think and give way to discussion which is given in paragraph 4.4.4.

4.4.4 Co-reflection

After the session with toolkits was completed, we first presented all our ideas to each other. Then a follow-up discussion about co-design and its results was held in the form of a semi-structured interview which gave some useful results on the utilisation of co-design for this specific target-group.

First of all, all participants felt that co-designing is a good tool to include users in its design. They felt that their opinion mattered and that they are really included in the design process of the tool. It was also fun in their opinion and would be open to do it again for other tools. However, there were some remarks that the organiser of the session used words that were too difficult for the participants with mental disabilities to understand. This could be attributed to working with different user groups and could be prevented by discussing with the caregivers beforehand if the explanation is too difficult.

4.4.5 Conclusion Session

Co-design is a useful tool to get additional information from an user with mental and physical disabilities. It provides a cosy environment which does not put the user in a spotlight and makes them feel more relaxed. Although the ideas generated during a toolkit session may not result in a final idea, the discussion afterwards does provide requirements which were not previously mentioned during observations and interviews. It was also useful to have different stakeholders in addition to the main caregiver and the final user to provide different insights.

Co-design should be used to design with vulnerable user groups so they really get the feeling that they are included in the design process. In addition, the different insights and remarks given by all the stakeholders that are participating are much more extensive than ones during interviews and observations because they have physical products they can relate to.

However, some adjustments should be made to each toolkit session catering to the specific disabilities that some users suffer from. For instance, it proved useful that each person suffering from either a mental or physical disability or even both is paired up with a caregiver. It allows both stakeholders to work together and make both of them feel comfortable and safe. A tip for future designers using co-design with a target group like this is to always consult with the caregiver beforehand to ensure a smooth session and be prepared for any difficulties.

4.5 Conclusion Ideation

The Ideation Phase was meant to conclude what the purpose of the tool should be in addition to general requirements. Additionally, the methods tested are evaluated to see how to incorporate it in a new design methodology.

(a) Cart (b) Attachment point on wheelchair

Figure 4.4: The cart and attachment point on the wheelchair

4.5.1 Product Conclusion

After multiple observation sessions, co-design, interviews, related works and individual brainstorms the conclusion could be made that Sanne wants a mechanism to attach/detach her cart. First of all, Sanne has a cart which can be attached to her wheelchair as seen in Figure 4.4. However, the problem is that she cannot attach/detach her cart on her own. She needs help from other people and has to wait until staff helps her to attach/detach the cart. Although Sanne is already able to drive around with a cart thanks to an attachment from the manufacturer of the wheelchair, a serious boost to Sanne her feeling of empowerment could be provided with a new design.

This cart is unique on It Aventoer and no-one else is able to do this particular job except for Sanne. This gives special meaning to the cart because it grants her a feeling of functional and cognitive empowerment. Although she does not say it outright, during the observations and co-design she looked happiest when driving around with her cart. Also, the specific case she chose during the co-design session was a mechanism to automatically attach/detach her cart which she never mentioned before.

4.5.2 Design Process Conclusion

A couple of methodologies were tested in this phase and evaluated afterwards. Observations proved to be crucial during the process because the designer can familiarise himself/herself with the situation. The designer could follow the user to observe any potential problems while asking questions. A PACT-analysis is useful to make afterwards that could serve as a summary for the situation and could help the designer with eventual requirements.

Interviews are really useful if the user can give helpful answers. Because Sanne was not yet familiar with the designer at this stage and has difficulty answering questions, an interview was not deemed practical. Although the author did not get conclusive results during an interview with the user, they could help if other users are able to answer questions. Additionally, interviews with people working in the healthcare sector who encounter these problems showed to be advantageous. Although they mainly helped the author with things to consider in the design methodology, they could also talk about their personal experiences when designing tools for people with disabilities.

A summary of co-design with a toolkit was already give in section 4.4.5 and will be incorporated in the design method. The general conclusion of this phase in the design process is to familiarise yourself with the situation and try to involve your users during idea-generation and brainstorming to let them feel a part of the process.

5 Specification

The following section will focus on the task of designing a towbar or other mechanism which allows Sanne to attach and/or detach the cart on her own. Various participation design methods will be used to acquire specifications while early prototypes are developed and tested.

5.1 Requirements

It is very important that the requirements for your design are clear before the development of early prototypes. All requirements are shown in Table 5.1 using the MoSCoW-method which were acquired during the Ideation phase in section 4.

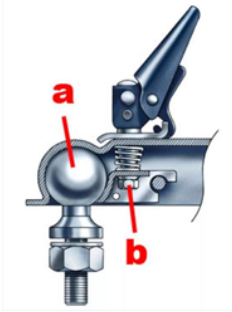
Must Have	**Should Have**	**Could Have**	**Won't Have**
a tool or mechanism that allows Sanne to detach/attach her cart by herself	easy ways to remove the tool	multiple purposes	any electronics
weatherproof parts	a way to allow Sanne to produce an action	a way that does not make her look more disabled	any social purposes
sturdy parts that will not break with a heavy load	a product that requires no service		

Table 5.1: MoSCoW Analysis of Requirements

5.2 Research into already existing Tools

Before designing early prototypes to test with Sanne, the author first had to determine existing tools which already exist that accomplish the same job. In the following Table 5.2 all existing mechanisms that are used to attach/detach objects to other objects, which the author found, are mentioned. The author was not an expert in the subject which made it very important to do research into different attachments.

Table 5.2: Analysis of Existing Mechanisms

Mechanism	Explanation
 (a) Tow ball [48]	A **Tow ball** mechanism is the most well-known mechanism to attach carts or trailers to cars. The trailer is pulled onto the ball(a) and by pushing the lever you can lock the nut(b) into place which secures the trailer onto the ball. The ball allows free movement of the trailer.
 (b) Tow Hook [49]	A **tow hook** are simple hooks which can be bolted onto several attachment points of vehicles. This way a strap or chain can be attached to both objects with a tow hook and allows one vehicle to pull another. However, this is not ideal because you have no control of the speed and movement of the the pulled vehicle unless someone is steering and/or breaking.
 (c) Fifth Wheel Coupling [50]	**Fifth wheel coupling** is a mechanism used to couple lorries to their trailers. Although the coupling is very big as this is mostly to reduce the friction and to distribute the load of the trailer over the coupling. The coupling is locked into the trailer using a lock jaw that pins the king pin into the coupling. Additionally, the tapered ends to the lock jaw are used so the king pin is lead into the jaw when the driver is manoeuvring the lorry into the trailer[51].

Mechanism	Explanation
 (d) Tow Pin	A **tow pin** is a simple mechanism where only a pin is used to lock two objects together. Sanne already has this mechanism attached to her wheelchair as can be seen in the Figure 5.2d.
 (e) Pintle Tow [52]	A **pintle tow** is a simple hook from which the top can be adjusted so it is out of the way which makes the lower hook available. A trailer with a ring can be put onto the hook. Then the top part of the pintle tow can be set into the previous position and a safety pin is used to lock the pintle tow.
 (f) Self Locking Pintle Hitch [53]	A **self locking pintle hitch** works about the same as a regular pintle hitch except that the top part does not need to be removed. The ring of the trailer can be driven into the pintle hitch and it will automatically lock the trailer into the pintle hitch. However, the safety pin still needs to be inserted by the driver and if the trailer needs to be removed, the lock mechanism also must be unlocked manually [53].

The author concluded that many of the mechanisms were unsuitable for Sanne. Mainly, most hooks require an action like putting the trailer onto a hook or inserting a safety pin. However, inspiration was gained from a fifth wheel coupling [51] where tapering towards the coupling is used so lorry drivers can drive into the trailer while not seeing a lot. This idea is perfect for Sanne because she also cannot see very much behind her wheelchair.

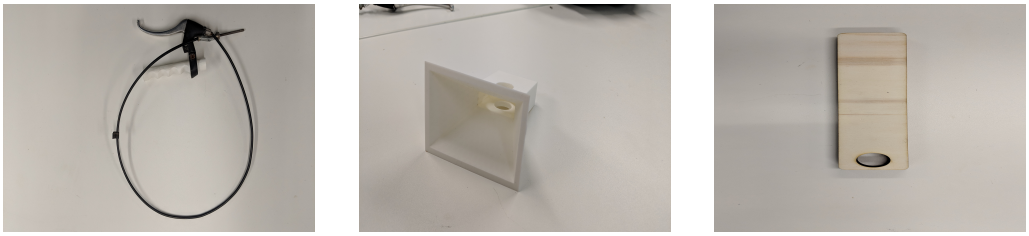
Additionally, a self-locking mechanism like the self locking pintle hitch [53] would be ideal but all versions found still require an action from the user at the hitch itself which Sanne is unable to do.

These results sum up that there is not really an existing mechanism that will suit Sanne

her needs. However, it does give an idea to specify and revise the current requirements and inspired the author on ways how to achieve those requirements.

5.3 Prototypes

A few early prototypes were developed using a lasercutter machine, 3D printers and other parts scavenged from objects. These prototypes were pure for testing to see if Sanne was able to do certain activities like squeezing a brake or manoeuvring her wheelchair in a certain way. Some of these early prototypes can be seen in the following Figure 5.1.



(a) Prototype Brake (b) Funnel (c) Attachment

Figure 5.1: Three early prototypes

Figure 5.1a was used to test if Sanne had the strength to squeeze a handbrake. The handbrake could be utilised as a mechanism to lift a pin that could attach and/or detach the cart to her wheelchair.

Figure 5.1b is a funnel which could guide a towbar mechanism as seen in Figure 5.1c into the funnel. This tool is used so that Sanne can manoeuvre her wheelchair with the towbar into the funnel by herself and would not need guidance from other people.

Figure 5.1c was used as an extension for the already existing attachment-point on Sanne her wheelchair as seen in Figure 4.4b because the current contraption cannot fit into the funnel properly.

All these prototypes were tested and the results are given in the following section.

5.4 Co-design with Prototypes

After the first iteration of prototypes Sanne was asked to participate in another session with the designer to promote user-inclusion. This was not only useful to test if the prototypes worked but also to receive feedback on the prototypes themselves. The designer followed a protocol as seen in Appendix D but the designer was allowed to deviate from the protocol to offer ample opportunity to ask more questions. The methods used are described in the following sections and will end with a conclusion on the results and the usefulness.

5.4.1 User-testing

The first prototypes as seen in Figure 5.1 were attached to Sanne her cart and/or wheelchair. First, Sanne was asked to perform a certain action before answering questions from the designer. This offered Sanne to have some time to think about the design while it allowed the designer to observe the actions of Sanne.

The **handbrake** was used to test if Sanne could squeeze it because she has limited strength in her fingers. This handbrake could be used to control a mechanism to lift a pin up and down. She was able to squeeze the handbrake with only her right hand, but proved to be too clunky to attach to her wheelchair. The armrest which it could attach to has to be free of obstructions to allow control of her wheelchair. Sanne uses that space to control the dashboard of her wheelchair. Furthermore, Sanne was not able to squeeze the handbrake and drive the wheelchair at the same time. This was useful to discover because she needed to squeeze and drive at the same time to lock the cart into the wheelchair.

The **towbar** was tested in two ways. First, the funnel was attached to the wheelchair with permission of Sanne. Afterwards, the designer held up the cart from its standard 'down' position as shown in Figure 4.4a so Sanne could drive the funnel into the cart as shown in Figure 5.2.

Figure 5.2: Sanne manoeuvring the funnel into the cart

Sanne was able to drive the funnel in one go into the cart which means that it is a valid way for Sanne to use this system to navigate her wheelchair into the cart. Although Sanne really liked the design she showed doubt if the funnel would not block her wheels or be in the way because it would extend the length of her wheelchair. This was really useful because the designer did not think of the way that her wheels would rotate when she turned her wheelchair. After testing it was determined that the funnel was not blocking her movement or range in any way.

The **towbar reversed** is the same contraption but reversed. The funnel is placed on the cart instead of the wheelchair as seen in Figure 5.3. This proved to be more difficult for Sanne because an extension was needed and her awareness of the dimension of the wheelchair were off. Additionally, this way the funnel is more fragile due to other people handling the cart.

Figure 5.3: Sanne manoeuvring the funnel into the wheelchair

5.4.2 Scenario-based Design

In addition to testing with the prototypes, short scenarios were constructed for Sanne and discussed. This lead to a discussion about help from staff which Sanne would like to minimise as much as possible. Additionally, she really dislikes the fact that an electric switch on her wheelchair that is used for opening doors in her parents home breaks down so often. If electronics are used she only wants something that works continuously but she does not mind if it stops because of a low battery charge.

5.4.3 Co-reflection

Co-design is a good way to include stakeholders in your design process and to see if the early prototypes are well received. Sanne mentioned that she really likes this way of designing and being included.

'I really like this because you are experienced in the design and building and I know more about my life and the wheelchair.'

Furthermore, Sanne came up with additional ideas during the session such as a way to lift the cart from its standard down-position as seen in Figure 4.4a which the designer had

other more difficult solutions for which involved the environment and other people.

The results of this prototype session concluded that there are three problems which need to be solved to let Sanne attach and/or detach the cart on her own.

1. Lift the cart from its standard down-position to an upwards position
2. A mechanism that allows Sanne to position the cart and the wheelchair without her being able to see it
3. A tool that can lock the cart and wheelchair together which Sanne can utilise

5.4.4 Co-design Conclusion

In summation, these techniques really prove useful to include the user more in the process which enables them to feel more empowered because they really feel that they have an influence on the design. Sanne was enthusiastic about more sessions with different prototypes.

However, the methods discussed above are not applicable to some people with different disabilities. People with impairments preventing movement of their whole body could not participate in physical testing. Fortunately, a lot of co-design methodology research has already been done for different disabilities. For example, Correia et al. [54] developed a method called 'PD4CAT – Participatory Design for Customized Assistive Technology'. This method also focuses on cerebral palsy and how to include the user. Furthermore, you also have participatory design where you need input from able-bodied and people with disabilities. Satterfield and and Fabri [55] use the Connectivity Model which allows people with disabilities to watch videos of the product and their reactions are observed by other stakeholders.

The suggestion of this author is to look into research articles before starting co-design methods to see if you can find methods applicable to your stakeholders. This will prevent that time is wasted unnecessarily on producing or adjusting methods.

5.5 Conclusion Specification

After the Specification phase all final requirements of the product are documented to keep into account for the realisation of the product. Additionally, the methods tested in the specification phase are discussed to see if they are incorporated in the design methodology.

Must Have	**Should Have**	**Could Have**	**Won't Have**
a mechanism that will not block the wheels of the wheelchair when turning	easy way to remove tool	electronics that require no service	any social purpose
reliable parts	a way to allow Sanne to produce an action	a way that does not make her look more disabled	multiple purposes
a way to hold the cart in an upwards position	a product that requires no service	a way that makes the device look a part of the wheelchair	
an automatic tool to attach/detach the cart	controls that are easy and accessible		
weatherproof parts			
a tool that aligns wheelchair and cart			

Table 5.3: Revised MoSCoW Analysis of Requirements

5.5.1 Product Conclusion

The requirements gotten from the Ideation phase in Table 5.1 are not complete anymore due to new requirements gotten through other methodologies. The revised requirements are given in Table 5.3. These requirements in addition to the prototypes that were tested allow for a final product idea in the next phase.

5.5.2 Design Process Conclusion

Research into related tools during the specification phase is needed when the designer does not have experience into the specific subject. The design method is aimed at not only regular designers but also other people who want to build or design for users with disabilities. That is why research into related tools is valuable because maybe a tool or device could already exist that could help or inspire the design. It could also give clues to potential problems your design might have and could be taken into consideration. Of course, when the designer is already an expert in the potential product this method could be less valuable.

User-testing with a few prototypes was most crucial in getting information. The prototypes provided during this co-design session gave Sanne something to talk about and she felt involved during the process. While the prototypes themselves are important to test concepts, the remarks made by the user during testing are even more important. Mostly, the remarks are something the users only realise during testing itself, such as not liking a certain concept.

6 Realisation

This phase features the final product idea and user testing to detect any imperfections in the design and to improve upon it. This phase will ultimately result in an evaluation to see if the design is complete and the stakeholders are satisfied.

6.1 Expert Interview

The author was not knowledgeable enough in designing a mechanism that could lift a pin and asked multiple people for quick meetings to ask them for suggestions. The handbrake as seen in Figure 5.1a did work to lift a pin but was too large to easily attach to Sanne her wheelchair. She was also only able to squeeze the handbrake with her right hand which she needed to drive her wheelchair. An expert in bio-robotics was consulted about different ways that could attach and/or detach such a cart.

A few things were suggested like the mechanism of a handbrake in a car, but every non-professional mechanical engineering solution proved to be too clunky or not reliable enough to work. Fortunately, we came to the conclusion that magnets could be the solution which will be further discussed in the next section.

6.2 Product

The prototypes in section 5.4.1 indicated three problems that needed to be solved. These problems which need to be resolved are individually discussed in the following paragraphs.

6.2.1 Lift the cart from its standard down-position to an upwards position

During the second co-design session in section 5.4 the author and Sanne came to the conclusion that there was not a way to lift the cart into a permanent upwards position. Usually, car trailers have a support leg with a wheel at the end because trailers are too heavy to lift and it allows users to ride the trailer into the tow bar.

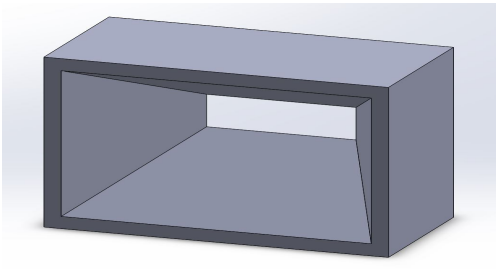
However, these mechanisms are too expensive and too big for Sanne's smaller cart. Research into support legs was done for carts that can be attached to karts. A support leg

Figure 6.1: Support leg for karts [56]

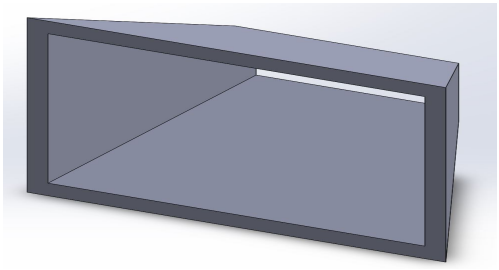
as seen in Figure 6.1 was found which could lock into a certain height which allows the cart to be in a standard upwards position which is not too high. The funnel could guide the cart upwards which lifts the support leg so it does not touch the ground and drags when Sanne is riding her wheelchair.

6.2.2 A tool that aligns the wheelchair and the cart

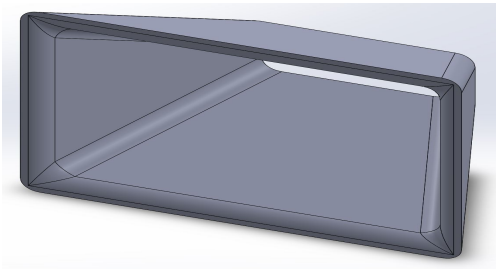
The funnel proved to work during the co-design session but had a major design flaw. The sides of the funnel would restrict the turning circle of the cart because it blocked the bar of the cart. This resulted in some design changes and the process can be seen in Figure 6.2. Then an attachment was added to funnel in which a pin can go through to lock the funnel, wheelchair and cart together. These final prototypes can be seen in Figure 6.3.



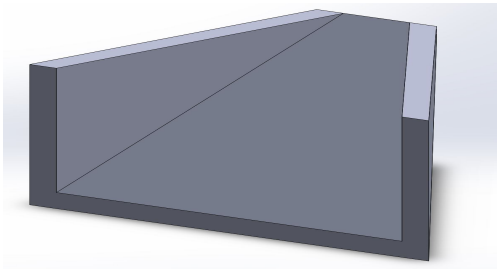
(a) Funnel Design 1



(b) Funnel Design 2

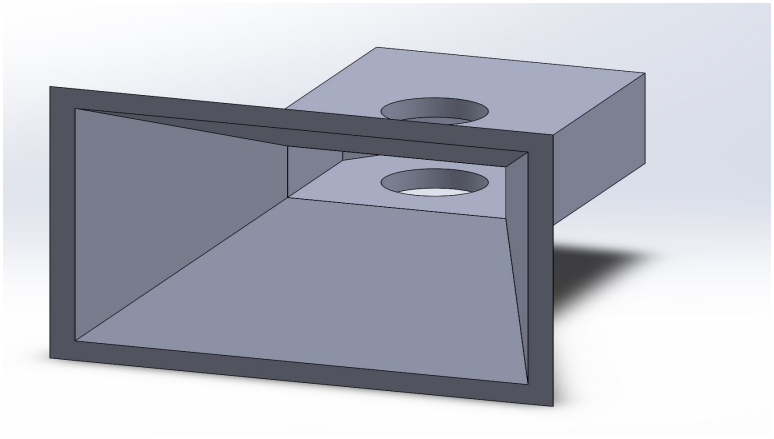


(c) Funnel Design 3

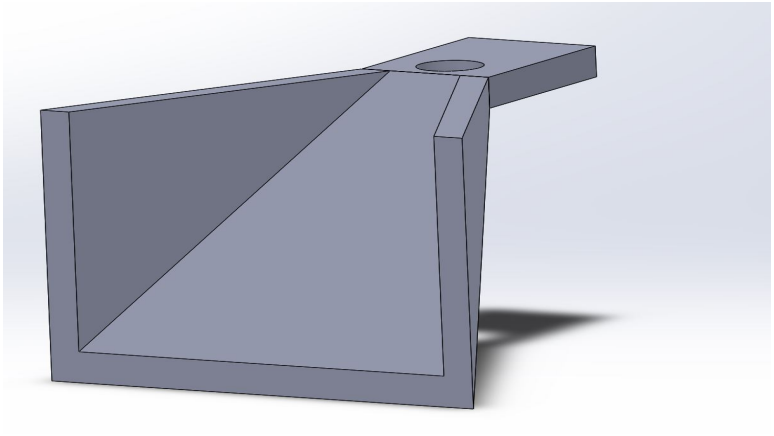


(d) Funnel Design 4

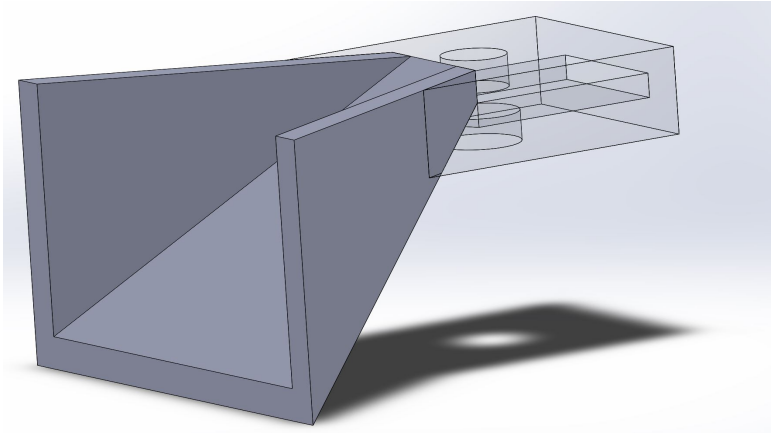
Figure 6.2: Design Process of the Funnel



(a) Final Prototype 1



(b) Final Prototype 2



(c) Final Prototype 3

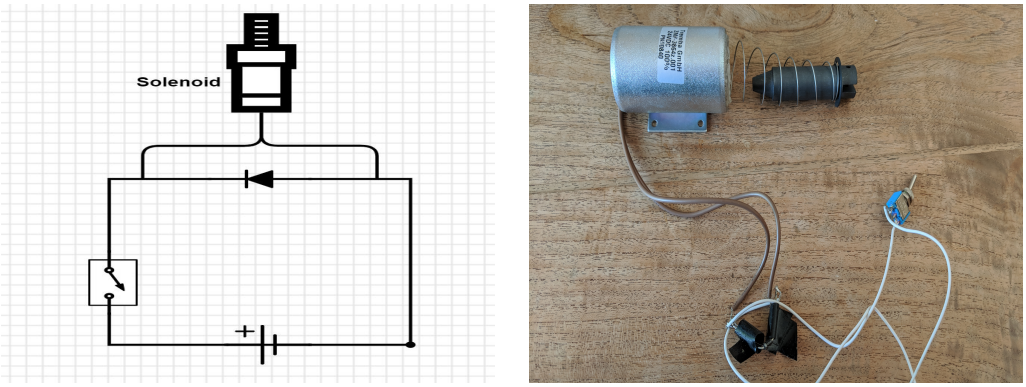
Figure 6.3: Final Prototypes Testing

Figure 6.4: The Solenoid

6.2.3 A tool that can lock the cart and wheelchair together which Sanne can utilise

The bio-robotics specialist suggested using a solenoid as depicted in Figure 6.4. A solenoid is a coil that converts electrical energy into magnetic energy. The pin is made from metal and is pulled into the solenoid when it is charged with electricity. This solenoid could be used to lift a pin that could lock Sanne her wheelchair and cart together.

In Figure 6.5b the solenoid used is shown together with a button that is soldered on and a power source. The power source used for testing was an adapter that had to be plugged in during testing because an external battery was too expensive to immediately order without testing first.



(a) Solenoid Electrical Scheme (b) The solenoid with button and power

Figure 6.5: The Solenoid with Switch

Figure 6.6: Support Leg attached to Sanne her Cart

6.3 Co-design Product Testing

The final products were tested with Sanne during another case of user testing. First of all, the support leg for Sanne her cart proved to work and can be seen in Figure 6.6. It was able to lift the cart in a certain way so it would not drag over the ground, hinder her wheels or bump into objects. Unfortunately, this caused some problems with the new funnel.

Three designs as seen in 6.3 were developed, but the designer made some miscalculations which caused the funnels in Figure 6.3a and 6.3c to not fit. However, one funnel fit perfectly and worked as expected.

Unfortunately, in combination with the support leg it proved that the material was not

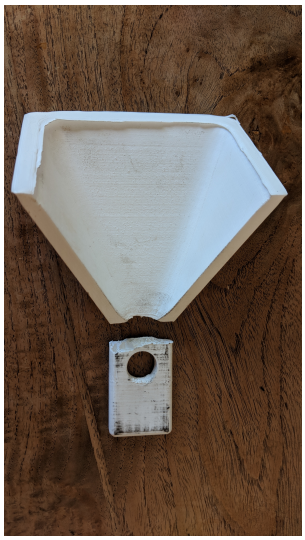


Figure 6.7: The broken funnel

strong enough. Although Sanne was able to manoeuvre the cart into the funnel, the plastic material of the funnel snapped. The result can be seen in Figure 6.7.

Lastly, the solenoid was tested and proved to work. However, adjustments are needed because during testing the solenoid was attached to the wheelchair. If the solenoid lifted the pin, it would lift it in a diagonal direction instead of vertical. This resulted in that if the pin needed to drop again, it would not fall in the correct way. This can easily be solved by attaching a block on the solenoid so it is further away from the wheelchair and directly above the pin. The designer simulated this by holding the solenoid with her hand as can be seen in Figure 6.8.

Lastly, Sanne was able to press the switch and was not concerned about attaching a battery to her cart because it is not in her sight and would not hinder the movement of her wheelchair.

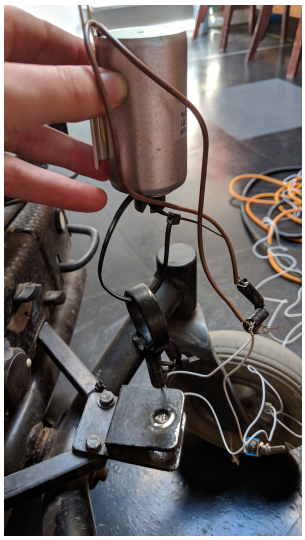


Figure 6.8: The Solenoid working

6.3.1 Co-reflection

After each session of co-design, a reflection session is useful to organise to evaluate the results. However, due to the session taking longer than expected, the author and Sanne were unable to reflect because Sanne had another appointment. The author does encourage to always reflect after each co-design session because now the author did not get the full picture of the feelings of the user about the product.

6.4 Conclusion Realisation

The conclusion of the realisation gives the results of the final product developed for Sanne and the final design process that is made. While the results are given here, the discussion will be done in section 7.

6.4.1 Product Conclusion

The final product was not satisfactory either towards the designer or the user. The product did not meet all the requirements. This could be because the distance between designer and user proved to be too large. Simple problems like a miscalculation in the funnel could

easily be solved by quickly testing if the funnel would fit in one minute. However, a gap of two hundred kilometres meant that quickly test-fitting was not an option. Also, problems like the solenoid needing to be further away from the wheelchair still and stronger materials for the funnel so it will not break, need to be solved.

6.4.2 Design Process Conclusion

In this section, a diagram will be given that shows the flow of the optimal design process that allows designers to work together with stakeholders that have multiple disabilities. Additionally, method cards were developed to give tips to people when designing for such a user group.

The diagram is shown in Figure 6.9 and is the final result after testing several methods with Sanne. The design methodology is from now on referred to as Pevadi (design methodology for people with various disabilities). The Design Process of Creative Technology as seen in Figure 2.1 is incorporated in the Pevadi methodology because it allows for three big testing moments together with your user. The Pevadi methodology allows designers and non-designers to see which methods work best, shows methods that involve user-inclusion and shows the optimal flow of these methods to achieve optimum feelings of empowerment. Additionally, you have several moments during each phase where contact is established with other stakeholders and the user in the form of co-design.

The colours represent either a product/result (blue) or the degree of involvement of the user. The pink methods are done solely by the designer and do not need input from others. The orange methods usually involve some form of stakeholder while the green methods are in cooperation with the user and/or stakeholders. This means that users of this diagram can quickly determine which methods involve the most user-inclusion.

The Pevadi methodology has three phases which are ideation, specification and realisation. Each phase begins with a result or product and different methods are given in each phase to further the design process. At the end of each phase there is a form of co-design incorporated to give the user power in the decisions that are being made and to evaluate.

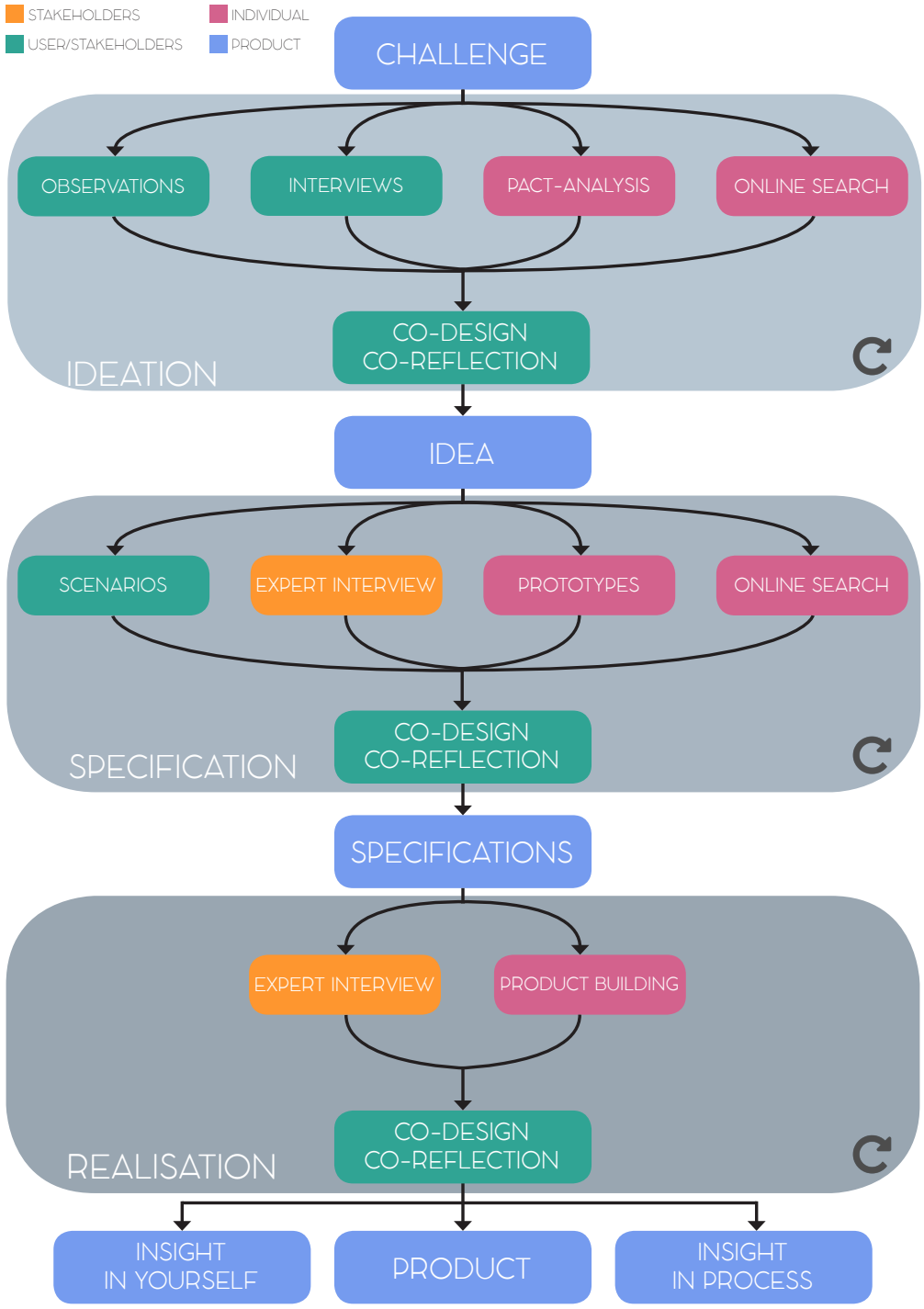
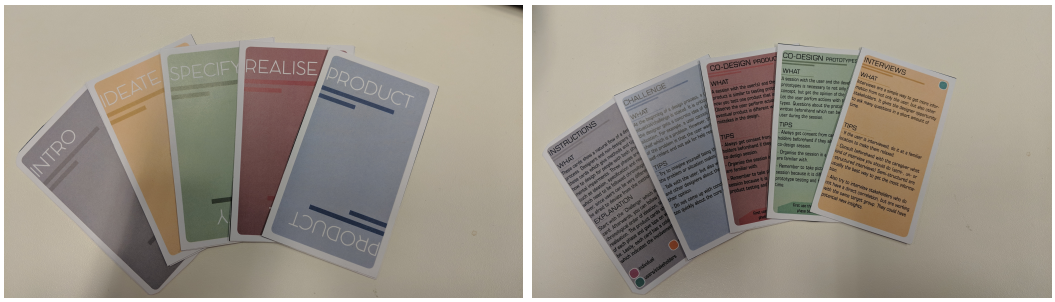


Figure 6.9: The Pevadi Flowchart

If the user and designer do not agree or have no progress, the phase has to be repeated although some methods can be skipped.



(a) Frontside (b) Backside

Figure 6.10: The Pevadi Method Cards

The design tool that is developed was made to help everyone who wants to design for people with various disabilities. The tool is shown in 6.10 and was created to accompany the flowchart. The flowchart is to quickly show the structure of the process while the method cards are used to give tips on how to design for this specific target group. Each card is attached to one object of the flowchart. The card shows on the front in which phase it belongs. The back of the card informs the users of the cards what kind of method they can use in the phase and tips on how to design for people with various disabilities and what to take into account. The whole method card set can be seen in Appendix E.

7 Discussion

In the following section a discussion will be held about the development of Pevadi. First, a look will be taken at the results and its limitations. The discussion will end with a section on how these results are added value to research.

Pevadi tries to incorporate user-inclusion for optimal feeling of empowerment but not bother the user too much. The co-design sessions at the end of each phase ensures that the user will be involved in the final decision of each phase. The results of the co-design sessions gave away that Sanne really liked being involved in the process which might mean that other users could appreciate it as well. Furthermore, not only the Pevadi methodology promotes empowerment during the design process as mentioned by van Dijk et al. [37], but the resulting tool promotes functional and cognitive empowerment as well.

However, the user could be included in more methods during the phases. The distance between Sanne and the author was an impediment during research because it meant that several methods were not tested. This means that Pevadi could be incomplete and needs future work research. Additionally, only one case study was used during the design process and for a vulnerable target group. Pevadi might not work for all cases but it also encourages to explore and adjust the methodology to work with your user.

The method cards developed to assist Pevadi is a way to explain the methods given and gives tips and trick to design with this target group. Unfortunately, the cards were not tested with designers, researchers or other stakeholders. Thus, it is not yet proven that these method cards could be of added value towards the design process or promote empowerment for users.

Additionally, Pevadi relies on people to be motivated to make such product but could look challenging for people with no experience in building. Although the author of this paper also had no mechanical experience, with help from other people she was able to build certain prototypes. The Pevadi methodology also encourages non-designers to build these products but offers no way to help with building. Although the method cards suggest using Fablabs or Makerspaces, which are spaces around the work with tools that everyone can

access, it could also be that certain users of Pevadi do not have such a space near them. Pevadi does not work if users of the tool are not able/willing to build a final product.

Although the Pevadi methodology itself has not been tested yet by other designers. Sanne and other stakeholders said that the design process, especially the co-design sessions, improved their sense of empowerment. Additionally, using this methodology adds a value by making specialised tools for these users which improves their sense of empowerment even further. A methodology to develop specialised tools focusing on co-design and empowerment has not been done before, so the results of this thesis can help other designers and researchers when designing for users with disabilities.

8 Conclusion

Functional empowerment is achieved when users can perform certain activities, but cognitive empowerment is most of the time an afterthought. Cognitive empowerment is enabling users to feel more self-confident and giving them the ability to control their life.

Tools for people with various disabilities are made to achieve functional empowerment. They are focused on accommodating users in the environment, help with daily tasks or helping able-bodied people assist people with impairments. There is a lack of providing cognitive empowerment in these three categories which is solved by including the user in the design process. Utilising co-design empowers users in a cognitive way because it involves them during decisions made in the design process.

Methodologies already exist that accomplish this but needs to be adjusted to accommodate people with various disabilities. The Pevadi methodology was developed that shows the structure of a design process in a flowchart and highlights which methods involves the users. Additionally, accompanying method cards were made which are used to show designers and non-designers tips and tricks when designing tools for users with disabilities.

The Pevadi methodology promotes cognitive empowerment by utilising methods that involve users and providing moments in the design process where users and designers together make final decisions. It is a tool that could provide significant assistance to people who do not usually design for such a unique target group. Most importantly, it empowers users because they can give their opinion about the tool/device developed.

8.1 Future Work

This paper ends with a discussion about potential improvements of the Pevadi methodology and gives considerations for the future.

Although a lot of time and energy has gone into designing the Pevadi methodology, specifically for users with various disabilities, it might still be improved. As mentioned in 7, Sanne was only one case study and methodologies used that worked for her might not work with other end users. Further research is needed to test this design methodology with other

stakeholders. Furthermore, only one designer used this method so other designers also have to be asked and motivated to start using Pevadi to see if it works.

One of the methods that could be improved is the various co-design sessions that were organised. They showed to be really promising for this user group. The participants showed interest and were motivated to collaborate as soon as they understood the meaning and purpose of the session. The author thinks that further research into co-designing with this group can give very promising results.

First, more co-design sessions need to be organised using toolkits with this user-group because the author only had three users with disabilities to test it with. Furthermore, different techniques could be utilised or thought of to make the session more interactive. The users do not only have mental disabilities but also physical which makes participating in creating ideas and showing it physically more difficult.

Secondly, the size of the group of participants could be researched. The designer had a group of six people which felt comfortable. Tests need to be done to see if bigger or smaller groups give more insight into the situation or might disturb the flow of ideas.

Lastly, the co-design session was done with additional stakeholders like the caretakers to make the participants with disabilities more comfortable. However, bringing in other stakeholders like family members and friends might also prove to be useful.

In addition to more research into co-design, the method cards need to be tested as well. As of now, they are bland looking cards with lots of text. Future researchers could look into adding more images to the cards so users of the cards are more attracted to them.

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A Co-design Session Structure

Preparation (20 min)

- Prepare all materials
- Set up videocamera and test

Introduction (10 min)

- Explain and sign consent-form
- Explanation co-design
- Explain that everything is allowed, do not limit your creativity

Brainstorm (10 min)

- Explain brainstorm about farm activities
- Give sticky notes to participants
- Let everyone write down all the activities of the farm (including activities Sanne cannot do)
- Put the sticky notes on A3 paper
- Choose one activity together
- Let Sanne choose one activity

Utilising the Toolkit (25 min)

- Short repitition about co-design
- Give example of result
- Two sessions of 10 min for each chosen activity
- Observe and take pictures

Evaluation (15 min)

- Present all ideas to each other
- General thoughts about the session
- Short semi-structured interview

    1. Did you think it was useful for generating ideas?
    2. Did you like/dislike co-designing with a toolkit?
    3. Was the difficulty factor alright?
    4. Would such a product empower Sanne?
    5. What would you like to do yourself and what should the object do?
    6. Should it have multiple functions?
    7. What limits you currently during activities?

Closure

- Thank everyone
- Clean up
- Analysis

B Consent Form

Instemmingsformulier

Project
Co-design met medewerkers, vrijwilligers en bewoners van It Aventoer over klussen op de boerderij
Onderzoeker(s)
Claudia Westerveld | c.e.westerveld@student.utwente.nl

Vraagstelling	**Graag aankruisen**
Ik bevestig dat ik het doel van het onderzoek heb begrepen en dat ik de mogelijkheid heb vragen te stellen	☐
Ik begrijp dat mijn deelname vrijwillig is en dat ik het recht heb me op elk moment terug te trekken, zonder opgave van reden	☐
Ik ga akkoord met de deelname aan bovengenoemd onderzoek.	☐
Ik geef mijn toestemming geluidsopnames te maken van de sessies	☐
Ik geef mijn toestemming video-opnames te maken van de sessies	☐
Ik geef toestemming foto's te maken van de sessies	☐
Ik geef toestemming de foto's te gebruiken in (wetenschappelijke) presentaties, waarbij gezichten onherkenbaar gemaakt zijn	☐
Ik geef toestemming (delen van) de opgenomen video en audio te gebruiken in (wetenschappelijke) presentaties	☐
Ik geef toestemming de transcripties van de opgenomen audio te gebruiken in (wetenschappelijke) publicaties	☐
Ik geef toestemming anonieme citaten te gebruiken in publicaties	☐

Naam deelnemer	Datum	Handtekening
Naam onderzoeker	Datum	Handtekening

C Interview Patyna

- What are your names?
- How long have you worked for Patyna?
- What is it that you do?
- Patyna mainly assists the elderly, but do they also have distinctive disabilities either mental, physical or both?
- Do you have examples of tools or technology that Patyna developed?
- What do the residents think of the technology that is developed to assist them?
- Do you also see differences in emotion when the elderly are using your technology?
- Do you develop tools or technologies for specific cases?
- What is your design process?
- How do you optimise the feeling of empowerment when designing these tools?
- How do you see the future of technology in the healthcare sector?
- Do you also experience that elderly feel isolated because technology is taking over the jobs of nurses?
- A lot of literature looks at technology that assist staff or able-bodied people to help people with disabilities. Is this also the case for Patyna?

D Structure of First Prototype Session

Preparation

- Test videocamera
- Prepare prototypes
- Find good spot to test

Introduction

- Explain to Sanne why I'm attaching things to her wheelchair and ask if I'm allowed
- Explain to Sanne the procedure of prototypes and Use-Case Scenarios
- Explanation the spotlight system

Prototype Handbrake

- Can you squeeze the handbrake?
- Would an attachment of this handbrake on your chair bother you?
- How would you feel if you could squeeze it and or could attach/detach your cart?

Prototype Towbar on Wheelchair

- How difficult was it to drive into the funnel?
- Would you like a system like this to attach to your cart?
- Would it be a problem if your cart had to be parked in the same spot all the time?
- Do you like the design?

Prototype Towbar on Cart

- How difficult was it to drive into the funnel?

- Would you like a system like this to attach to your cart?
- Would it be a problem if your cart had to be parked in the same spot all the time?
- Do you like the design?

Scenario-based Design

- How would you feel if the system would fail?
- What if someone would move your cart?
- What would you do if the system would break or be stuck?

E Pevadi Method Cards Set

PRODUCT

SPECIFY

REALISE

IDEATE

INTRO

INSTRUCTIONS

WHAT

These cards show a natural flow of a design process. Designers and non-designers can use these cards which give methods and tips on how to design for people with both physical and mental impairments. Three phases are utilised such as ideation, specification and realisation which need to be followed chronologically. However, since users can be very different, do not be afraid to deviate from the methodology.

EXPLANATION

Start with the 'Challenge' which is a product card. Afterwards, you can follow the phases in chronological order of ideation, specification and realisation. The product cards show the results of each phase and give tips on what they should be. Lastly, each card has a coloured square which indicates the involvement of the user.

individual

stakeholders

users/stakeholders

CHALLENGE

WHAT

At the beginning of a design process, a problem/situation/challenge is stated. It is critical that the designer gets a concrete idea of the exact situation. For example, a user cannot reach a shelf which is a problem. However, the core of the problem is that the user wants to be self-reliant and not ask for help reaching it.

TIPS

- Try to imagine yourself being the user and how the problem or situation makes you feel.
- Talk with the user, but also with stakeholders and other designers about the problem to get their opinion.
- Do not come up with conclusions on your own too quickly about the core of the problem.

ONLINE SEARCH

WHAT

Online search is essentially using search engines to look for similar situations or problems. You can use research papers, videos or other credible sources to look for information about the case or other information that is needed to get ideas.

TIPS

- It could be helpful to look into other reseach that has been done for the disabilities the user might have. It could be that a solution for the problem already exists.
- Do not be afraid to use sources that are not official. The best ideas might come from the most unexpected sources.

OBSERVATIONS

WHAT

Although observations are very simple, they are most critical in understanding your user. The designer observes the user for several days while paying extra attention when the user does actions involving the challenge.

TIPS

- Do not be afraid to note everything down on paper. Observing and getting the feeling of the user is more important. If you really want to get everything, film the observation.
- See if you can perform the task involving the problem with the same disability as your user. For example, if the user cannot walk, the designer also cannot walk.
- Ask many questions during the observations. Anything that pops into your head.

INTERVIEWS

WHAT

Interviews are a simple way to get more information from not only the user, but also other stakeholders. It gives the designer opportunity to ask many questions in a short amount of time.

TIPS

- If the user is interviewed, do it at a familiar location to make them relaxed.
- Consult beforehand with the caregiver what kind of interview you should do (semi-, un- or -structured interviews) Semi-structured are usually the best way to get the most information.
- Also try to interview stakeholders who do not have a direct correlation, but are working with the same target group. They could have potential new insights.

PACT-ANALYSIS

WHAT

A PACT-analysis is an existing framework which is used to better understand and obtain a good analysis of the current situation. To achieve this, write down which People are involved, what Activities are done, the Context of the environment and which Technologies are currently used.

TIPS

- Do not make the PACT-analysis too extensive because you might lose sight of the most important points.
- You can use other methods in the Ideation phase such as interviews and observations to determine what you need to put in your PACT-analysis.

CO-DESIGN TOOLKIT

WHAT

At the end of the ideation phase organise a co-design session. Prepare a toolkit filled with miscellaneous building materials and adhesives. Brainstorm together with your users/stakeholders for ideas and physically build them using the toolkit.

TIPS

- Consult with caregives for a timeframe to keep the attention of users.
- Make duo's of one user with a stakeholder they're familiar with.
- Keep in mind the various disabilities the users might have.
- Organise the session in a place that the users are familiar with.

First use the other methods in this phase before using co-design.

CO-DESIGN REFLECTION

WHAT

After utilising the toolkit during the co-design session, it is important to reflect. First, everyone talks about their presented ideas. Afterwards, a discussion is held about the best idea. If there is not a definitive conclusion, it might be better to go through the ideation phase one more time.

TIPS

- Try to let everyone state their thoughts. If a user or stakeholder does not say much, try to ask a direct question.
- Look at reactions from the user during answers from other stakeholders or try to ask them follow-up questions.

First, use the co-design toolkit method and then you can reflect.

IDEA IDEATION

WHAT

At the end of the ideation phase, an idea should be the result. It does not need to be set in stone, the specification phase is used to identify the functions of the eventual product so the eventual idea might change a little.

TIPS

- Keep the idea general, the next phase is used to do research into specifics of the product.
- Make sure that everyone agrees with the eventual idea.
- Do not be discouraged if you do not have an idea, repeat the ideation phase to get more knowledge and inspiration.

ONLINE SEARCH

WHAT

If you have a general idea for your end-product, it is useful to look on the internet for similar products. There could already be a perfect solution or these products could inspire a new design.

TIPS

- Experience shows that a lot of products are not mentioned or researched in papers. Although not very professional, people on Youtube might also have good ideas.
- Do not be afraid to call a company that specialises in the niche of your product. They might have a similar product or know who does.

EXPERT INTERVIEW

WHAT

An expert is somebody who is assumed to have expertise knowledge in a subject that the interviewee or other people do not possess. It is useful to interview people who have experience in building your eventual product or similar products.

TIPS

- It is useful to do the expert interview before building prototypes because they might have better solutions.
- Do not be afraid to approach people for an expert interview. Most of the time they are willing to talk because they are interested in your idea as well.
- Make sure that the questions you prepare are specific.

SCENARIOS

WHAT

Scenarios are cases which describe activities done by humans to achieve goals in the format of pictures or words. This makes it more accessible for users. These scenarios are given to users so they can give their opinion about them.

TIPS

- Try to think of scenarios which would bother the user, like the product breaking down. They will likely think of other cases where products failed them and mention it. This could help when designing the final product.
- Also try to think of different scenarios which would involve other people like family or caregivers.

PROTOTYPES

WHAT

Prototypes are simple physical product that are build to represent ideas in a tangible way. They are most of the time simplistic realisations of the ideas of the designer and made of simple materials such as paper, duct-tape or wood. Build a few prototypes which can be tested.

TIPS

- Do not be too extensive with your prototypes, they are only meant to test your ideas. Save your time when building your real product.
- If you do not have the resources or skills to build something yourself, look for Fablabs or Makerspaces near you. They have machines like 3D-printers and lasercutters and the employees can help with the design of prototypes. The machines are available for everyone for a small fee.

CO-DESIGN PROTOTYPES

WHAT

A session with the user and the developed prototypes is necessary to not only test the concept, but get the opinion of the user as well. Let the user perfom actions with the prototypes. Questions about the prototypes are written beforehand which can be asked to the user during the session.

TIPS

- Always get consent from caregivers/stakeholders beforehand if they also agree with this co-design session.
- Organise the session in a place that the users are familiar with.
- Remember to take pictures/videos of the session because it is difficult to focus on the prototype testing and the user at the same time.

First use the other methods in this phase before using co-design.

CO-DESIGN REFLECTION

WHAT

After prototype-testing during the co-design session, it is important to reflect. First, discuss every prototype individually and let the user answer your questions. Afterwards, discuss together with your user what the best prototype was and which they liked most.

TIPS

- Be patient when reflecting with your user. It depends on the user, but some need more time to think of an answer.
- Pay attention to their facial expressions. It may suggest more about their opinion than their actual answers.
- If you are not sure, review the session with a caregiver/family member who know the user better. They can tell you more about the actual opinion of the user.

First, use the co-design prototypes method and then you can reflect.

SPECIFICATIONS

WHAT

At the end of the specification phase, your testing will have given you a concrete idea of the product and its requirements. Divide requirements into must have's, could have's, should have's and won't have's. This is the MoSCoW-method and gives you specifications which can be user during the realisation phase.

TIPS

- Look up examples of MoSCoW frameworks to see good specifications of functions.
- Always confirm with the users if they agree with all the functions and requirements of the product.
- Do not be discouraged if you do not have enough specific requirements, repeat the specification phase to get more knowledge and inspiration.

PRODUCT BUILDING

WHAT

Although it is similar to building prototypes, the results of the specification phase are now utilised to focus on building the actual product. This is more advanced than prototypes and is an eventual product that will be used by the user.

TIPS

- Review your previous prototyping session to see what went wrong or right.
- During building, check several times what the requirements are so you do not forget something.
- As mentioned in the specification phase, if you need help with building, look for Makerspaces and Fablabs near you.

EXPERT INTERVIEW

WHAT

Although expert interviews are usually done in the specification phase, they are useful during the realisation phase as well. Especially if the prototypes differ a lot from the eventual product, it is useful to get advice from experts about the new product.

TIPS

- It is useful to do the expert interview before building the product to prevent mistakes in the design.
- Do not be afraid to approach people for an expert interview. Most of the time they are willing to talk because they are interested in your idea as well.
- Make sure that the questions you prepare are specific.

CO-DESIGN PRODUCT

WHAT

A session with the user(s) and the developed product is similar to testing prototypes, but now you test one product that is complete. Observe the user perform actions with the eventual product in different ways to spot any mistakes in the design.

TIPS

- Always get consent from caregivers/stakeholders beforehand if they also agree with this co-design session.
- Organise the session in a place that the users are familiar with.
- Remember to take pictures/videos of the session because it is difficult to focus on the product testing and the user at the same time.

First use the other methods in this phase before using co-design.

CO-DESIGN REFLECTION

WHAT

This is the final reflection for the product to see if the user is happy with the eventual design and no mistakes have been made. Discuss with the user and stakeholders if this is the product they were looking for and if they are satisfied.

TIPS

- Pay attention to their facial expressions. It may suggest more about their opinion than their actual answers.
- If they are not satisfied, try to ask why they did not like it or if they had other expectations.
- Do not be discouraged if the users are unhappy with some aspect of the design. For example, it could be that they do not like the colour which is fixed easily with paint.

First, use the co-design product method and then you can reflect.

PRODUCT REALISATION

WHAT

After all the phases, a product should be the result that empowers the user in their daily life. If this is not the case, repeat the realisation phase.

TIPS

- It could be that the product breaks down after a while. Do not be afraid, just go through the realisation phase again to fix it. Problems with materials or electronics sometimes only arise after a while.

INSIGHT IN YOURSELF (REALISE)

WHAT

It is important to evaluate yourself after following a design method. It is important to think of what you have learned. Not only in functional skills but also of the struggles of users with disabilities, does such a method work for you and how you have improved yourself.

TIPS

- Write down everything that you have learned. This does not need to be extensive and can just be small sentences.
- Use this information in later projects to improve your work ethics and skills.

INSIGHT IN PROCESS (REALISE)

WHAT

It is important to review with the user, designers and other important stakeholders how the process went. What have your learned about the user, does everyone in the process know each other better and would this process work again?

TIPS

- It is nice to end the design process with your user in an informal setting.
- Every user is different so write down potential methods/problems with your specific users so future designers can take those into account.
- Also evaluate with the stakeholders if they would like to do this again and what they have learned from the user.