

THESIS FOR THE DEGREE OF LICENTIATE OF PHILOSOPHY

Same needs but different meanings.  
A comparison and analysis of the individual assistive mobility transfer  
device needs of four different categories of users.

PAMELA LINDGREN



**CHALMERS**  
UNIVERSITY OF TECHNOLOGY

Department of Industrial and Materials Science  
Division Design & Human Factors  
CHALMERS UNIVERSITY OF TECHNOLOGY  
Gothenburg, Sweden 2023

Same needs but different meanings. A comparison and analysis of the individual assistive mobility transfer device needs of four different categories of users.

© Pamela Lindgren

Licentiatavhandlingar vid Chalmers tekniska högskola,

Rapport no IMS-2023- 9

Published and distributed by

Department of Industrial and Materials Science

Division Design & Human Factors

Chalmers University of Technology

SE-412 96, Gothenburg, Sweden

Telephone +46(0)31-772 1000

Cover by Pamela Lindgren

Printed by Chalmers Digitaltryck

Gothenburg, Sweden 2023

All illustrations and photos by Pamela Lindgren, unless otherwise stated.

## Abstract

The purpose of this licentiate thesis is to contribute to the knowledge about user needs for individual mobility assistive technology (AT) transfer devices. Two qualitative user studies, which were part of a design project, constitute the empirical data. The studies consisted of semi-structured interviews with users that were analysed to identify the needs of users in four user categories (primary users, senior relatives as informal caregivers of relatives, professional home health caregivers, and orthopaedic ward hospital staff) for an individual mobility AT transfer device. The analysis aimed to identify and compare needs beyond those of functionality and usability. The findings showed that the needs of users in different user categories for an AT were partly the same, but that some needs were associated with different meanings and significance for different categories of users. Features communicating purpose, use and how to handle the device conveyed not only instrumental aspects, but also 'soft' aspects such as aesthetics and meaning. Whereas instrumental needs such as needs for functionality, usability, accessibility and security were equally important across user categories, the importance of 'soft' aspects differed. Functional needs were relatively easy for the users to describe in detail compared to needs for aesthetics, meaning and emotional experiences and consequences of use although the 'softer' needs were described as equally important to be met for use and the ability to accept AT by the primary users.

Keywords: assistive technology, user studies, user needs, user-centred design

## Foreword

My personal background is in product and industrial design, working as a professional designer and consultant. I have a Master of Fine Arts Degree (MFA) from the School of Design and Crafts at the University of Gothenburg (HDK). My master's project consisted of designing a new type of electrical wheelchair, which was intended to be both functional and aesthetic. The background to the master's thesis project was based on my own situation, living with the consequences of a spinal cord injury, and using multiple assistive technology (AT) aids in my everyday life. Therefore, it is of personal and professional interest to investigate users' needs for, experience of, and factors underpinning users' acceptance and use of AT devices. My overall experience of using various AT aids is that the design of these products focuses on functionality and totally lacks aesthetic qualities. This experience was shared with other users of AT products whom I interviewed during my studies at HDK. The research at Chalmers University of Technology focused on AT products to further investigate AT users' needs for and experience of these products to understand how to design for acceptance and adoption of AT aids.

## Acknowledgements

I would like to thank my supervisor, Professor MariAnne Karlsson, for her patience and confidence in my academic work over the years. Without her vast knowledge and experience within the field of Human - Technology Systems and her guidance of and input to my work, I would not have had the courage to continue my research journey. I also want to thank my co-supervisor, senior lecturer Bijan Aryana for engaging in my thesis work and providing expertise in the field of product design and for solid feedback and guidance.

My research studies are based on user studies in which volunteer participants took their time to be interviewed and share their knowledge of and expertise on their needs for assistive technology. Without their participation, this licentiate thesis could not have been accomplished. Therefore, my heartfelt thanks go to all the participants whom I had the pleasure of meeting and interviewing. The information they provided has widened my understanding of users' different needs for assistive technology. Many thanks also to all the knowledgeable colleagues and lecturers at Division Design & Human Factors, Department of Industrial and Materials Science at Chalmers who have helped me through the preparatory doctoral education courses, specifically Associate Professor Oskar Rexfelt for participating in paper writing and contributing with knowledge and expertise in the field of Human Factors.

I would also like to thank my close friend, Docent Margaret Myers, for supporting me to keep trying to improve my writing and pushing me to keep going when I doubted my abilities, and my friend Margareta Kreuter, Associate Professor at the University of Gothenburg, for encouraging me to participate and conduct research from my personal /patient perspective as well as that of a designer. Last but not least, an enormous thank you to my great family and my wonderful friends for always being there whenever I needed them.

## Glossary

*Acceptance* - the verification or approval that a specific product, object, service, etc., meets qualification specifications and is useful for its purpose.

*Adoption* - whereby a person has accepted a product, technology or object, chosen to use it and continues to embrace and make full use of it.

*AT* - assistive technology

*AT abandonment* - non-use (positive or negative) of AT.

*Attractive values* - generally shared principles and ideas of what is valued as attractive and desirable.

*Context* - the associated factors or related circumstances depending on the setting such as situation, surroundings, milieu or environment etc.

*Cultural norms* - socially shared expectations that are based on fixed guidelines or constructions derived from laws or religion etc.

*Elicit* - to evoke or draw out a reaction, response, or information.

*Emotional experience* - refers to the dimensions of subjective reactions people experience as they interact with something such as an object or product etc.

*Emotional reactions* - subjective experience, behavioural response or reaction that affects someone's disposition, such as love, disgust, fear, desire, pride, despair etc., and thus influences motivation, decision making and so on.

*Functional or instrumental value* - refers to the extent a product is perceived to be functional, practical/useful, e.g., with appropriate performance outcome or consequences such as physical performance, effectiveness, and ease of use.

*Functional or instrumental needs* - tangible or concrete needs for a product (device, tool, object, or service) for example, basic functional needs to do or perform something, including usability, accessibility, and safety needs when performing the actions the product is designed for.

*Hedonic* - refers to pleasure and satisfaction.

*Impairment* - The term is generally used to refer to loss of bodily parts or functioning, while disability is used to describe societal consequences of impairment (Oliver, 1990; 1996). The World Health Organization (WHO) International

Classification of Functioning, Disability and Health (ICF) describes that the functioning and disability of an individual occur in a context, i.e., '*dynamic interaction between a person's health condition, environmental factors and personal factors.*' (WHO, 2001). In this thesis impairment and disability are used as they are described in the publications referred to at the time of each reference.

***Life quality or quality of life*** - "*An individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns.*" (WHO, 1993).

***Meaning*** - literal or abstract signification or associative meaning, interpretation evoked by a word, object, or product other than its literal or primary meaning such as idea or feeling based on personal beliefs and socio-cultural understanding of meaning.

***Mediating tool*** - something used to entice reflection or association e.g. in a user study (Karlsson, 1994).

***Product experience*** - experience elicited by the interaction between user and product including aesthetic experience, experience of meaning, and emotional experience.

***Product expression*** - refers to what a product expresses through its appearance.

***Product semantics*** - refers to what a product appears to communicate through its design within a cognitive and social context of use.

***Rejection*** - the act of not accepting or considering something (like a product), to discard or refuse to accept or consider using it.

***Semiotics*** - the study of signs. In relation to products, seeing products as signs able to be represented (Monö, 1997).

***Semantics*** - In relation to products, semantics is the study of a product's meaning (Monö, 1997).

***Socio-emotional needs*** - psychological needs such as emotional relationship to others and with others, such as acceptance, belonging, empathy, affection, security, trust etc.

***Social norms (or just 'norms')*** - specific guidelines, implicit rules and constructions within a social setting that specify how people should and should not behave. Social

norms can be influenced by moral, religious or political beliefs that affect an individual's understanding and sense of right and wrong.

*Social values* - socially constituted and shared general guidelines or standards within a social setting influencing people's experience and understanding of what is expected, what is acceptable or not acceptable, such as what is desirable, attractive, or hankered after.

*Soft needs* - 'tacit' or intangible needs including needs for aesthetics, meaning, positive emotional experiences and consequences of use.

*Soft aspects* - tacit or intangible perceptions or understandings that are not expressed directly, including perceived values or aspects of products such as aesthetic qualities, emotional or social consequences of use, expression and meaning or association, as well as identity aspects, and hedonic aspects that can be evoked by objects or products etc.

*Symbolic associations or meaning* - in relation to products, what a product appears to say or symbolise against a background or context based on socio-cultural agreements or shared understanding of the meaning of symbolic interpretation between individuals.

*Symbolic value* - refers to the value attributed to an object, product or idea that communicates a meaning.

*User needs* - refers to the needs that users have for a product (e.g., device, tool, technique, or service) to perform or do something, like an action to achieve an objective or goal. This includes e.g. functional needs and soft needs.

# Table of Contents

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	USERS' ACCEPTANCE AND REJECTION OF AT	2
1.1.1	Functionality	2
1.1.2	Aesthetics and appearance	2
1.1.3	Perceptions and associations	3
1.1.4	Other influencing factors	4
1.2	KNOWLEDGE GAPS	5
1.3	RESEARCH RATIONALE	7
1.4	AIM AND RESEARCH QUESTIONS	9
1.5	ORGANISATION OF THE THESIS	9
<b>2</b>	<b>FRAME OF REFERENCE</b>	<b>11</b>
2.1	PRODUCT BENEFITS	12
2.2	PRODUCTS AS SYMBOL-BEARING OBJECTS	13
2.3	THE PRODUCT PLEASURE FRAMEWORK AND THE HIERARCHY OF NEEDS	14
2.4	PRODUCT SEMANTICS	16
2.5	SUMMARY	21
<b>3</b>	<b>RESEARCH PROCESS</b>	<b>24</b>
3.1	THE DESIGN PROJECT	25
3.2	THE RESEARCH STRUCTURE	28
<b>4</b>	<b>USER STUDIES</b>	<b>31</b>
4.1	OVERALL APPROACH	31
4.2	USER STUDY 1	33
4.2.1	Aim	33
4.2.2	Method	33
4.2.2.1	Interviews	33
4.2.2.2	Participants	34
4.2.2.3	Analysis	35
4.2.3	Findings	36
4.2.4	Conclusions and implications	41
4.3	INTERMEDIATE STEP: DEVELOPING THE SDQ	43
4.4	USER STUDY 2	43
4.4.1	Aim	43
4.4.2	Method	44
4.4.2.1	Interviews and questionnaires	44
4.4.2.2	Participants	45

4.4.2.3	Analysis.....	45
4.4.3	Findings.....	46
4.4.4	Conclusions and implications.....	50
<b>5</b>	<b>ADDRESSING THE RESEARCH QUESTIONS .....</b>	<b>52</b>
5.1	ADDRESSING RQ1A AND RQ1B.....	52
5.1.1	Identified needs.....	52
5.1.2	Similar needs but different meaning.....	53
5.1.3	Methodological issues in eliciting information on needs.....	54
5.2	ADDRESSING RQ2.....	57
5.2.1	The product as whole.....	57
5.2.1.1	Functional features.....	58
5.2.1.2	Technical components.....	59
5.2.1.3	Form characteristics.....	60
5.2.1.4	Arrangement of parts and components.....	61
5.2.1.5	The influence of the use environment.....	62
5.2.2	The product as a symbol.....	63
5.3	ADDRESSING RQ3.....	65
5.3.1	Fulfilling users' conflicting and contradictory needs.....	65
5.3.2	Understanding, interpreting, and implementing users' needs.....	66
5.3.3	Communicating a message.....	67
5.3.4	Choosing the design strategy.....	68
<b>6</b>	<b>GENERAL DISCUSSION AND CONCLUSIONS .....</b>	<b>71</b>
6.1	REFLECTIONS ON THE THEORETICAL FRAMEWORK.....	71
6.2	REFLECTION ON THE CHOICE OF METHODOLOGY.....	73
6.3	CONCLUSIONS AND CONTRIBUTIONS.....	75
<b>7</b>	<b>REFERENCES.....</b>	<b>78</b>
	<b>APPENDIX 1.....</b>	<b>86</b>
	<b>APPENDIX 2.....</b>	<b>90</b>
	<b>APPENDIX 3.....</b>	<b>94</b>
	<b>THE SEMANTIC DIFFERENTIAL QUESTIONNAIRE (SDQ).....</b>	<b>97</b>



# 1 Introduction

Today over one billion people (corresponding to 16%) aged 15 years or older live with disability and the number is vastly increasing, partly due to rises in non-communicable diseases and demographic trends in terms of an ageing population (WHO, 2023). Globally more than 2.5 billion people need one or more assistive products. By 2050 it is expected the number will have increased to 3.5 billion (WHO, 2023). Practically all people will experience temporary or permanent disability during their lifetime (ibid.). However, with proper support from social welfare and healthcare services, along with appropriate technology such as Assistive Technologies (ATs) (ISO 9999, 2022), it is argued that people have an opportunity to live independently, regardless of age, impairment, and disabilities (Scherer and Glueckauf, 2005; Lansley, McCreadie, and Tinker, 2004; Stumbo, Martin, and Hedrick, 2009; Agree, 2014; WHO, 2018). AT can help compensate for limitations and postpone or reduce the need for formal healthcare, long-term care, or personal assistance, and contribute to an overall better quality of life (Hoenig, Taylor, and Sloan, 2003; Lansley, McCreadie, and Tinker, 2004; Agree, 2014; Freedman, Kasper, and Spillman, 2017; WHO, 2018).

The term *Assistive Technology* (AT) is defined by ‘The Technology-Related Assistance for Individuals with Disabilities Act (commonly known as the “Tech Act”) as *“any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities.”* (United States Assistive Technology Act of 1988, amended in 1994 and 2004). The World Health Organization (WHO) defines Assistive Technology (AT) as an umbrella term that includes systems, services, and products with the primary purpose of supporting individuals to *“maintain or improve an individual’s functioning and independence, thereby promoting their well-being”* (WHO, 2018). The definition is similar to The International Standards Organization's (ISO) definition of “assistive product” that in turn is aligned with ICF terminology (revised definition from 1998, i.e. ISO 9999). Thus, ISO defines AT as *“... especially produced or generally available, for persons to optimize functioning and reduce disability”* (ISO, 2022).

## 1.1 Users' acceptance and rejection of AT

Despite all the possible positive effects that AT may provide for individuals, literature over the past few decades suggests that AT devices, specifically those developed to support individuals to maintain or improve functioning and independence, are abandoned, rejected, non-used, or not used as intended by the users (e.g., Phillips and Zhao, 1993; Scherer and Galvin, 1996; Hocking, 1999; Riemer-Reiss and Wacker, 2000; Wessels et al., 2003; Sugawara et al., 2018). There is evidence that as much as one-third of all AT products are rejected or abandoned (Phillips and Zhao, 1993; Scherer, 1997; 2005; Scherer and Galvin, 1996; Kintsch and DePaula, 2002; Holloway and Dawes, 2016). The proposed reasons for why users abandon or reject AT products vary from aids not matching user expectations or not fulfilling user needs, to associations ascribed to ATs, as well as other factors such as social consequences of use, all of which influence user acceptance and adoption. Interrelated factors influencing users to abandon or reject AT are described below.

### 1.1.1 Functionality

One category of factors can be termed functionality factors, which in this case means that the AT does not meet or serve users' functional needs or expectations (Wielandt and Strong, 2000; Pape, Kim and Weiner, 2002; Wessels et al., 2003; Federici and Borsci, 2016). Poor performance, ineffectiveness, malfunctions, difficult to use, and unsuitable size and dimensions for the environment of use, or physical environmental restrictions are examples of factors that influence user acceptance of ATs (Phillips and Zhao, 1993; Wielandt and Strong, 2000; Wessels et al., 2003; Federici and Borsci, 2016).

### 1.1.2 Aesthetics and appearance

Development of ATs with a narrow focus only on functionality only comes at the expense of aesthetics (Bichard et al., 2007; Pullin, 2009; Shinohara and Wobbrock, 2011, 2016; Spinelli et al., 2018; Spinelli et al., 2019), which can impact users' willingness to accept ATs. Beyond the need for ATs to be functional and easy to use, they must also

be aesthetically pleasing (Kintsch and DePaula, 2002; Newell, 2003), matching individual preferences (Wessels et al., 2003; Scherer, 2005). Furthermore, an unpleasant appearance can elicit negative reactions and unwanted attention from other people, which in turn can influence AT use (Wessels et al., 2003; Parette and Scherer, 2004; Shinohara and Wobbrock, 2011). Bichard et al. (2007) conclude that *“No one wants to be a product of an assistive product, which embodies aesthetics few would accept given a choice”* (p. 628).

### 1.1.3 Perceptions and associations

Factors that affect users' acceptance or rejection of ATs also depend on what users themselves associate with ATs (Pape, Kim and Weiner, 2002; Wessels et al., 2003; Shinohara and Wobbrock, 2011; Spinelli, 2019; Astell et al., 2020). Associations can be influenced by personal factors including a person's characteristics, abilities and expectations (Scherer, 2005), as well as personality, individual preferences, and experience with and exposure to technology (Philips and Zhao 1993; Hocking, 1999; Scherer, 2005; Scherer and Glueckauf, 2005). Equally important for acceptance may be other people's perceptions of and attitudes towards AT products (Hocking, 1999; Pape, Kim and Weiner, 2002; Wessels et al., 2003; Scherer and Glueckauf, 2005; Shinohara and Wobbrock, 2011, 2016; Bright and Coventry, 2013; Spinelli et al., 2020).

AT design features can negatively emphasize impaired AT users' disabilities and influence their experience of being 'marked' by the products (Parette and Scherer, 2004; Bichard et al., 2007; Shinohara and Wobbrock, 2011; Shinohara and Wobbrock, 2016). The appearance of traditional ATs has for example been criticized for reproducing narratives of medicine, decline, restriction, dependency, and limited ability (Söderstrom and Ytterhus, 2010; Spinelli, 2018; Spinelli et al., 2019). According to McCarty (1992 in Mallin and de Carvalho, 2015) heavy and embarrassing designs *“reinforce isolation feelings and the people's inadequacy with disability, contributing to their stigmatization for the society”* (p. 5571). If the aids are perceived to give rise to such negative associations this can lead to rejection by users (e.g. Pape, Kim, and Weiner,

2002; Parette and Scherer, 2004; Söderström and Ytterhus, 2010; Shinohara and Wobbrock, 2011; Spinelli et al., 2019; Bright and Coventry, 2013).

AT designs have also been described as potentially stigmatizing by offering a standardized, "neutral" or "for all" aesthetic (Naess and Ortsland, 2005, in Bichard et al., 2007), lacking styling qualities and thus preventing people from projecting their preferred personal identity through the objects they use and are associated with. AT designs that do not match users' preferred self-image or identity can be perceived to be uncomfortable or embarrassing to use (Phillip and Zhao, 1993; Hocking, 1999; Wielandt and Strong, 2000; Pape, Kim, and Weiner, 2002; Parette and Scherer, 2004; Bright and Coventry, 2013). Thus, even if working well from a functional perspective, AT aids can have negative effects on users' self-confidence and social inclusion (Shinohara and Wobbrock, 2016) by eliciting unwanted attention by highlighting demeaning features or disability (Shinohara and Wobbrock, 2011; 2016). A lack of self-confidence can result in people preferring other alternatives or help from other persons instead of using AT aids (Wielandt and Strong, 2000; Scherer et al., 2003; Bright and Coventry, 2013; Chester, Hocking, and Smythe, 2020).

Furthermore, people with various impairments or disabilities who use AT aids temporarily or permanently are often supplied with similar, standardized, 'one-size-fits-all' AT designs, regardless of their age, background, individual preferences, and socio-emotional needs (e.g., social acceptance, belonging), and how these needs evolve over time (Spinelli et al., 2019). This is despite or regardless of the notion that a 'one-size-fits-all' approach is considered implausible when it comes to AT, as needs and context of use are unique to each individual (Kintsch and De Paula, 2002).

#### 1.1.4 Other influencing factors

AT acceptance and rejection can also be related to the provision systems of ATs, such as poor assessment of the user's needs, mismatches between person and technology (Scherer, 2005; Scherer and Glueckauf, 2005) and factors related to the user's possibility

to influence. In Europe, ATs are often provided through national healthcare or welfare systems (European Commission (EC), 2003; Nordic Centre for Rehabilitation Technology (NUH), 2007; Steel and de Witte, 2011). This is the situation in some countries outside Europe too, while in others the procurement system is a mixture of private and public providers (Federici and Borsci, 2016). Additionally, intermediary bodies and healthcare professionals (e.g., physiotherapists or occupational therapists), select, suggest, and prescribe these aids to people in need of them (Nordic Centre for Rehabilitation Technology (NUH) 2007; de Witte et al., 2018). This means that the end users of AT are not the buyers of AT (Wessels et al., 2003; de Witte et al., 2018). In some countries, people who need AT have to pay for this themselves (Federici and Borsci, 2016; de Witte et al., 2018) but AT is most often provided as a loan, as a means of medical rehabilitation (Nordic Centre for Rehabilitation Technology (NUH), 2007). The result is that many people who would benefit from AT do not have access to assistive devices because they are not able to pay for the aids (de Witte et al., 2018).

## 1.2 Knowledge gaps

It is generally acknowledged within social psychology, marketing research, design research as well as design practice that users' needs for products are not only functional. The interplay between functions and factors like aesthetics, identity, self-image, self-confidence, social and personal values and norms etc., also affect user's perception and experience of products (e.g., Dittmar, 1992; Lai, 1995; Jordan, 2000; Norman, 2004; Desmet and Hekkert, 2007; Mallin and de Carvalho, 2015; Shinnohara and Wobbrock, 2016) and hence also AT users and their possibility for acceptance and adoption of AT.

The previously mentioned publications (of which only a fraction are mentioned) conclude that AT aids are rejected and abandoned by their primary users (i.e., people for whom AT is intended to support activities, participation, and independence) as the aids do not fulfil users' needs or expectations. However, who explores and collects information on factors influencing AT users' needs and perceptions (and the resulting

acceptance or rejection of an AT product), may affect what factors are identified and how they are interpreted, as well as what aspects are penetrated more in-depth. Most of the prior AT publications are grounded in a rehabilitation perspective where different healthcare professions (such as occupational therapy, physiotherapy, etc.) have investigated primary users' needs for AT, possible benefits, and reasons for non-use and rejection. In comparison, there are considerably fewer publications that are based on a design perspective when investigating AT users' needs, experiences, and preconditions for acceptance, use and reasons for non-use.

However, there are exceptions to the latter, such as Kintsch and De Paula (2002), Bichard et al. (2007), Shinohara and Wobbrock (2011; 2016), Bright and Coventry (2013), Spinelli et al. (2018; 2019), and Mallin and de Carvalho (2015) who describe AT users' experience of use, needs for AT, and adoption (or non-use) etc., to be influenced by social acceptance, psychological consequences of use, emotional aspects such as fear of being stigmatized, other people's perception of AT users' capacity and abilities, and the need for ATs to be stylish and to look more like mainstream products. Although these publications highlight the importance of considering these factors in the design of AT to make these types of products more acceptable and enjoyable, they do not provide information about which specific characteristics in the AT design contribute to making them stigmatizing, or stylish and acceptable, by primary users or by other user categories and non-users. Thus, more in-depth information on what factors in the design of AT products give rise to positive or negative perceptions, associations and experiences is not available. A lack of information that supports design decisions may be one reason for the observed difficulty to create and offer solutions that fulfil users' different needs. Therefore, it is here argued that *for designers to design AT products that users can accept and counteract negative experiences associated with using these products, more detailed information is needed on what in the AT design users perceive and experience as positive and negative and why.*

In addition, many AT aids are used not only by people with impairments or disabilities but also by people who help them, for example, relatives as informal caregivers, as

well as by professional caregivers, such as home services and hospital staff. While there are publications that describe these other user categories and their needs for AT as well as their impressions and experience of AT, the studies have predominantly focused on one or two groups, for example, informal and/or professional caregivers (e.g., Czarnuch and Mihailidis, 2011; Mortenson et al., 2013; Saborowski and Kollak, 2015; Mortenson et al., 2018). However, there appear to be very few studies that have investigated and compared different user categories' needs for AT solutions that are used by different user categories in different environmental contexts, for example, individual AT mobility transfer solutions that are commonly used both at hospitals and in homes. Thus, the possible consequences of different user roles, use situations, and contexts of use of ATs have not been compared, and nor have any potential conflicting needs between user categories been identified even though this is important information that can guide designers to fulfil user needs for AT. *Therefore, in order for designers to design AT products that meet user needs and acceptance, more detailed information is needed on different user categories' needs, as well as differences and possible conflicts between these categories and their influence on AT design.*

### 1.3 Research rationale

If an AT aid is rejected by its user(s) then it is not functional, even if it could potentially meet the functional needs in a hypothetical setting perceived by professionals in the healthcare systems, the designers, or the manufacturers. Then the question is how useful these ATs are in supporting independence and promoting well-being? When an AT product, such as an individual mobility aid, is abandoned or rejected despite being needed this can limit an individual's mobility and reduce their independence. This can result in less social engagement, which in turn can lead to isolation with negative consequences for well-being (Scherer and Glueckauf, 2005; Verza et al., 2006; Bright and Coventry, 2013; Spinelli, 2018; Spinelli et al., 2020), not to forget that many people feel uncomfortable or stigmatized by using ATs but have to use them anyway for accessibility reasons.

Although the mentioned factors have effects at an individual level more than at a systemic, economic level (Kintsch and De Paula, 2002; Federici and Borsci, 2016; Spinelli et al., 2020), they still have negative effects at an economic and environmental level in terms of products being manufactured but then abandoned or not used (Sugawara et al., 2018). If the rate of AT abandonment follows what has been indicated in previous studies, showing that as much as one-third of all AT products are rejected or abandoned more than 1.16 billion of all AT products produced globally by 2050 will be abandoned.

Considering the negative individual, socio-economic and environmental effects associated with AT abandonment or rejection, creating preconditions for AT acceptance and adoption is an urgent need. Therefore, more in-depth user studies are needed to investigate and identify user needs for ATs that are to be used in different environments by different user categories, to understand which needs these users have, if there are similarities and differences and if any needs are emphasized by all or by one category of users but not another. Furthermore, there is a need for studies that identify and analyse in more detail what aspects in the design of AT products give rise to negative or positive perceptions and associations and why. This is information that is important for AT developers and designers to be aware of and understand to design AT that fulfils users' needs and thereby increases acceptance and use. It is also information that is important for decision-makers to know and understand when deciding on future investments in healthcare services. In addition, knowledge of how ATs should be designed to better meet the needs and expectations of different user categories can also pave the way for users of other products with similar problems, who may also benefit from the core concept of this research.

In summary, there is a need to:

- (i) develop further knowledge of users' needs for different types of ATs from a design perspective,

- (ii) find out if and how the needs of different AT user categories differ (or not), and
- (iii) identify and analyse in more detail what aspects in the design AT products give rise to negative or positive perceptions and associations and why.

#### 1.4 Aim and research questions

Within ongoing research aimed to investigate '*how to design AT for acceptance and adoption*' the purpose of this licentiate thesis is to contribute with more in-depth knowledge of AT needs of different user categories, more specifically those needs and preconditions that are connected to user acceptance of AT. One way to investigate this matter is through user studies in which different users' needs can be identified. Thus, the following questions have been addressed based on two user studies including interviews with four categories of intended end-users of a mobility AT transfer device:

- RQ1a: Which needs do users in four user categories (i.e., individuals with impairment and/or disability needs, relatives as informal caregivers, hospital and professional home caregivers) have for mobility AT transfer devices?
- RQ1b: Which needs (if any) are similar and which differ between these different user categories?
- RQ2: What in the design of AT products gives rise to negative or positive perceptions and associations and why?
- RQ3: What are the implications for design?

#### 1.5 Organisation of the thesis

- Chapter 1 introduces the area, the problem and the questions posed.
- Chapter 2 presents the frame of reference.
- Chapter 3 provides an overview of the research approach and the design project used as a case study to investigate and find answers to the research questions.

- Chapter 4 summarises the user studies, i.e., User Study 1 and User Study 2, as well as the intermediate step of developing a semantic differential scale (SDQ).
- Chapter 5 provides insights from the analysis of the user studies in relation to the frame of reference. The chapter is structured in two parts. Answers are given, firstly to research questions RQ1a and RQ1b, describing the needs of four user categories for an AT, similarities and differences between their needs, and possible links between their needs and willingness to use and accept such AT. The chapter then addresses RQ2 and the participants' reactions to design features in the AT are analysed in relation to the perceptions they gave rise to and implications for design are presented. Finally, RQ3 is addressed.
- Chapter 6 provides a general discussion where the findings are reflected upon through the lens of the frame of reference. In addition, the chapter presents reflections on the theoretical framework used and its relevance for understanding the information elicited in the user studies, as well as reflections on the choice of methodology. The chapter ends with the conclusions drawn and the contribution of the work.

In the Appendix, three papers produced on the information gathered in User Studies 1 and 2 are attached, as well as the SDQ that was used in User Study 2.

The appended papers are:

- Paper 1. *Exploring challenges in designing a multifunctional AT device.*
- Paper 2. *Moving beyond functionality and safety. Challenges in Designing AT for well-being,*
- Paper 3. *Practical experiences with different ways of eliciting information on 'soft' user requirements for assistive technology.*

## 2 Frame of reference

Within the Human Factors (HF) tradition, making products usable and safe has traditionally been a key issue. However, other aspects related to how people interact with, and use products have become increasingly important to consider when developing and designing products with the aim to offer users positive use experiences. Detailed user information is needed to understand how users perceive and experience AT products and what needs they have. From a design perspective, information on users' needs must first be elicited, understood by the designer and be interpreted into design parameters to be addressed in the design of the product. The process must be grounded in an understanding that user needs for products are not only functional but that aesthetics, meaning, social aspects etc., are important in order for users to accept and adopt a product.

Searching the literature, there are several theories and models from different relevant fields, such as cognitive science, psychology, anthropology, consumer behaviour and marketing, as well as various design frameworks, for example, user experience and product experience. Literature also provides descriptions of methods to elicit user information, such as interviews, surveys, observations, focus groups, experimental studies and information from the sale of goods. These can all be used as a basis when trying to identify and understand users' needs for and experience of products.

Considering the overall research aim, *i.e.*, '*how to design for acceptance and adoption*,' the licentiate thesis is centred on identifying and comparing the respective needs of four different categories of users for accepting an AT device. Therefore, theories and frameworks categorising different types of user needs have been included for the purpose of identifying and comparing needs beyond those of functionality and usability, more particularly theories and frameworks concerning product benefits, products as symbol-bearing objects, product pleasures, and product semantics. These are aspects that were believed important to consider in a first step to investigate and

understand how different categories of users perceive and understand ATs, and which needs they may have and why.

## 2.1 Product benefits

Product benefits can be defined as any positive impact a product has on a user's experience when interacting with or using it. Among theories about product benefit, the framework of product valuation proposed by consumer behaviour and marketing researcher Albert Wenben Lai provides an overview including a typology of eight generic product benefits that consumers may derive from consumption, possession, or use of a product (Lai, 1995).

1. *Functional benefits* are concrete attributes that the consumer can experience directly when using or consuming the product, i.e., a product's functional capacity, utility or physical performance.
2. *Social benefits* refer to perceptual benefits that can be obtained through the product's connection with social class, social status, or a certain social group.
3. *Affective benefits* refer to the perceptual benefits obtained from a product's ability to evoke emotions or affective states such as personal, idiosyncratic meanings, tastes, memories and cultural-ethnic meanings, etc.
4. *Epistemic benefits* refer to the benefits obtained from a product's ability to provide novelty or meet a desire for knowledge, as well as to satisfy curiosity, for example, novelty and variety-seeking consumption behaviours and customers' tendency to adopt new products.
5. *Aesthetic benefits* are benefits obtained from a product's ability to provide a feeling of beauty or to increase personal expression.
6. *Hedonic benefits* describe the benefits obtained from a product's ability to satisfy the need for enjoyment e.g., pleasure, fun or as a distraction from work etc.
7. *Situational benefits* refer to the benefits obtained from a product's ability to meet specific needs in specific circumstances.

8. *Holistic benefits*, finally, refer to the perceptual benefits obtained from a product constellation as a whole, formed by a product combination of complementarity, compatibility, coherence and consistency.

The diversity of Lai's potential benefits, including functional, affective and aesthetic benefits is relevant to include as a basis for the research as they widen the perspective when trying to understand possible benefits that users can seek in and attribute to products and which may affect the needs they experience, as well as what needs must be fulfilled for acceptance.

## 2.2 Products as symbol-bearing objects

Some of Lai's generic benefits, such as the social, affective and aesthetic benefits, resemble the social psychologist Helga Dittmar's (1992) explanation of products as symbol-bearing objects used to communicate or enhance a person's identity to her/himself as well as to others. According to Dittmar (*ibid.*), the symbolic meanings attached to products are culturally defined and determined by cultural context. Thus, people communicate their identity through the objects they own, whose symbolic meaning is socially shared. Dittmar developed the symbolic-communication model in which she conceptualizes objects as 'symbolic mediators of identity.' The model schematizes and divides the relationship between identity and object-related meanings into two aspects; *instrumental* and *symbolic*. Instrumental refers to functional use and direct control over the environment, while symbolic refers to identity expression, i.e., 'who somebody is.' The aspects are further subdivided into three associated meanings; use-related, self-expressive and categorical.

The instrumental aspect:

- *Use-related meaning* refers to activities made possible by objects. Use-related meanings also symbolize that the owner is capable, in control and able to engage in various activities made possible by the object.

The symbolic aspect:

- *Self-expressive* refers to aspects associated with products that allow the people who own them to express personal qualities. Thus, associated symbolic meanings or attributes of products can be used to differentiate the product owner from others by representing and reflecting the person's unique identity.
- *Categorical* refers to the associated symbolic meanings of products that allow people owning them to express group identity and group membership, social position or status and values. As such the categorical aspects of a product are used to integrate people with others.

Dittmar's model is relevant for the scope of this thesis as it may provide and deepen the understanding of potential symbol-bearing meanings that users can attribute to or ascribe as products and, hence, reflect needs such as being able to communicate identity, group affiliation, etc.

### 2.3 The product pleasure framework and the hierarchy of needs

Yet another approach to understand how users perceive products beyond functionality and usability (which nevertheless are essential if positive feelings are to be experienced) is provided by the designer Patrick Jordan. Jordan's framework is built on prior work by the anthropologist Lionel Tiger (1992) who developed a pleasures framework intended as a model for classifying and addressing four types of pleasures that he claimed to be universally found in cultures. Jordan presents the "Four Pleasures" framework, in which he distinguishes four types of pleasure that people seek to derive from products, i.e., physical, psychological, social, and ideological pleasures (Jordan, 2000).

- *Ideo-pleasure* refers to pleasures arising from personal ambitions, tastes, and values, like cultural, aesthetic, and moral values, aspirations, and beliefs. Associated design characteristics express values embedded in a product, i.e., 'what the product stands for.'

- *Socio-pleasure* describes pleasure arising from company/relationships with others, friends, loved ones, and/or being part of society as a whole or like-minded groups. Associated design characteristics facilitate social interaction and/or characteristics to express a message, such as image, social identity, or status.
- *Psycho-pleasure* refers to pleasures derived from cognitive and emotional rewarding experiences and enjoyable flow. Associated design characteristics are for example efficiency or usability.
- *Physio-pleasure* refers to physical pleasures derived from the five sensory organs (hearing, touch, smell, taste and sight). Associated design characteristics include for example tactile properties or visual appearance.

Jordan's pleasure model is also related to his "hierarchy of consumer needs" model (Figure 1, Jordan, 2000) which is inspired by the psychologist Abraham Maslow's theory of *the hierarchy of human needs* (Maslow 1987). Maslow organized human needs in hierarchical levels; the basic physiological and safety needs are at the bottom level, followed by belongingness and love needs, self-esteem needs, and self-actualization needs at the top level. According to Maslow, the basic needs must first be satisfied – although not necessary *'be satisfied 100 percent'* (Maslow, 1987, p. 69) for individuals to be motivated to fulfil higher level needs. Thus, if only basic needs are met individuals will still not be satisfied if the higher needs are not met. Maslow's hierarchy of needs theory is commonly used (see e.g., Crilly et al., 2004) to compare and describe how users' needs shift from satisfying basic functional needs, towards striving to satisfy self-esteem and self-actualization needs. Jordan (2000) used Maslow's basic idea to illustrate how users' needs emerge and change over time. Like Maslow, Jordan argues that users must first be ensured that their basic functional needs are met before other needs become relevant.

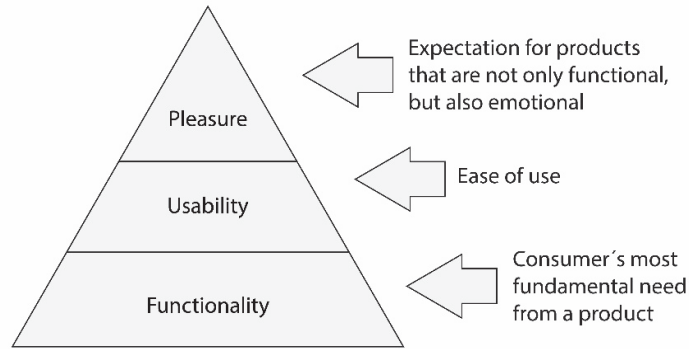


Figure 1. Jordan's hierarchy of consumer needs (from Jordan 2000).

Jordan's pleasure framework is useful to include given the scope of this research as it partly resembles and complements Lai's generic benefits and Dittmar's symbolic communication model by providing insight into how users perceive, and experience needs for products grounded on different types of sought-after pleasures.

## 2.4 Product semantics

To further widen the perspective of different user needs for products, it is helpful to understand how users perceive, make sense of, and value products. The industrial designer and design theorist Rune Monö (1997) used a semantic approach based on the idea that the design of a product communicates a message – regardless of whether the product is designed to convey a message or not.

Monö's semantic view of product design is partly based on the communication theories by linguist Karl Bühler (1879-1963) and his *Organon* model (Figure 4), which was developed to define and describe the functions of linguistic communication. The *Organon* model comprises a sign (as a stimulus) at the centre of the model, a sender and a receiver. This model was also used by the art historian Ernest Hans Gombrich (1909-2001) (in Monö, 1997) to examine the function of pictures as part of the function of language. This work was the inspiration for Monö's effort to describe how a message can be transposed into visual product signs.

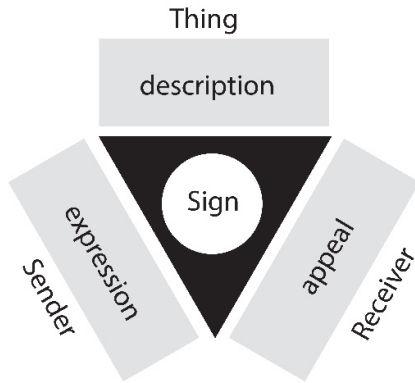


Figure 2. Bühler's Organon model (from Monö 1997)

Additionally, Monö's view of the product as a communicator of a message is influenced by Claude Shannon (1948) and his model, which describes a generic communication system in which a message is sent and received. The communication system includes five essential elements: source, transmitter, channel, receiver and destination. Monö applied Shannon's model to the study of product design to demonstrate how a message can be sent through a product gestalt representing the source by which designers transmit a message to users (Monö, 1997). Thus, the designer(s) is considered as the *source* of the message, and the product as the *transmitter* of the message. The environment/context in which the users interact with the product is viewed as the *channel* and the users' perceptual sensory capabilities as the *receiver* of the message. The user's interpretation and response to the transmitted message is the *destination of the message* (see Figure 5).

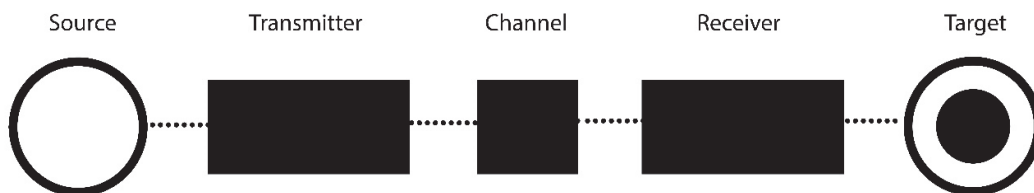


Figure 3. Illustration of Monö's view of communication, where he uses Shannon's communication model from 1948 (Shannon, 1948).

Any message that is to be transmitted can be interrupted at each step of the process. This means that if it is not clear what is to be communicated (source) and if there are flaws in the physical gestalt or ambiguous semantics (transmitter), or deficiencies in the marketing (channel), physiological deficiencies (receiver) and psychological deficiencies or preconceptions (target) this can result in the message not being perceived as intended (ibid., p. 45.).

Monö describes the product as a kind of trinity, consisting of three aspects or dimensions: *the ergonomic whole*, *the technical whole*, and *the communicative whole* (Figure 2).

- *The technical whole* contains the product's technical functions, construction and production.
- *The ergonomic whole* contains everything that concerns modifications of the design to fit the human physique and behaviour when interacting with and using the product.
- *The communicative whole* designates the product's capacity to communicate with users and its adjustment to human intellect and perception.

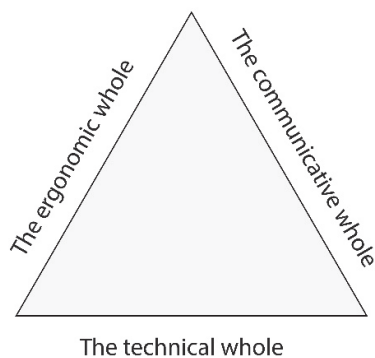


Figure 4. Monö's product trinity (from Monö, 1997).

The three dimensions are equally important in describing the totality of function and appearance as a whole. Consequently, the message receiver's perception of the gestalt, i.e., the "phenomenon we can discern as a whole" (Monö 1997, p. 32) (including the product's form, material, colour, surface structure, sound, etc.) is based on "an

arrangement of parts which appears and functions as a whole that is more than the sum of its parts." (Monö, 1997, p. 33). Thus, the conjunction of different dimensions and parts of a design influences how the receiver experiences as a whole, i.e., as a gestalt.

The message that is being sent through the product gestalt is received and interpreted by a receiver - the user. To communicate a message through the product gestalt the designers/developers must create the product design based on four semantic (meaning) functions (Figure 5):

- *To describe* the product's purpose, way of functioning, and how to handle or use it, e.g., how it should be gripped or turned etc.
- *To express* the product's properties or qualities, e.g., stability, lightness, softness, etc.
- *To exhort* the user's instant reactions or behaviour, e.g., that the user should be careful or precise when interacting with the product.
- *To identify* the product's origin, product group or product category.

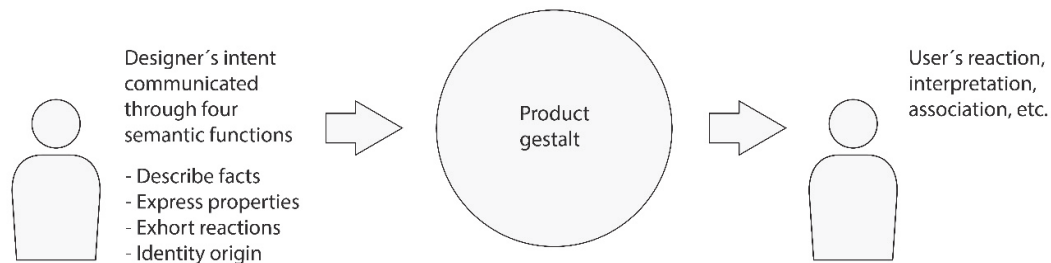


Figure 5. An illustration of Monö's product semantic functions communicated through the product gestalt (from Monö 1997).

These semantic functions are jointly interpreted as a whole and translated by the user (i.e., the receiver of the message), resulting in recognition, feelings, evaluations, conceptions and impulses to act and understand.

According to Monö, it can be difficult to distinguish between the functions 'to express' and 'to describe.' Still, there is a clear difference. To exemplify, he uses the design of cars. These vehicles have four wheels that carry a box with two levels of roof, one for the engine and one for the passengers; these are describing facts. However, cars have different looks and styles, where some models express speed, spaciousness, status etc., (ibid. p. 94), i.e., express properties. A product's properties can also express other characteristics, such as friendly, inviting, aggressive etc. (ibid.).

From a design semantic perspective, product developers must be aware of what the product must communicate or 'say' to be understood by the user to be able to use it (ibid., p. 76). How to communicate the message that is created through the semantic functions (needless to say) varies between product developers and designers of products within the same product category or kindship depending on the expectations of the target group that the manufacturing company wants to attract. However, if the "new" design differs too much from what users recognize as the hallmark, i.e., the current product sign of a certain type of product it risks not being recognized by users (ibid., p.66).

Furthermore, how a product is perceived and understood, as well as what meaning it transmits and the resulting perception, understanding and emotional responses it can elicit, differs between users and their use situations and/or use contexts, as well as their social and cultural values. Thus, opinions and tastes and whether a product will be perceived as attractive, aesthetical, or ugly are influenced by a complex network of forces such as personality, situation, values, and attitudes shaped by social and cultural values and norms. Monö lists some of the levels that influence people's attitudes to products, i.e., individual qualities (e.g., temperament, physical settings like right or left-handedness, height etc.), upbringing, experience, education and/or training, as well as societal setting (ibid.).

Monö's thoughts on the influence that social settings, cultural norms and values have on how people perceive, and value products are also described by Crilly et al., (2004). The latter also share Monö's explanation of how the full spectrum of human senses influences people's reactions to products and other objects, i.e., individual physical conditions and characteristics such as experiences, values, beliefs and preferences (Crilly et al., 2004). This is similar to Dittmar's (1992) explanation that a product or object that is perceived to be socially acceptable, attractive, or desirable to possess and use varies depending on individual aspects, preferences, and social values (Dittmar 1992). However, by using Monö's semantic perspective, an additional design perspective is provided to understand users' interpretations of product meaning (including the totality of function and appearance as a whole) which can influence which needs they describe and emphasise to be fulfilled for acceptance and use.

## 2.5 Summary

Lai's eight generic product benefits, identified in the context of marketing research and consumer behaviour (Lai, 1995), are useful in understanding possible benefits that users of a product may experience from possession, consumption, or use of a product. Therefore, Lai's eight generic benefits are useful to gain an understanding of the possible benefits (and related needs) that users of AT may search for in possessing and using products. To complement the potential benefits users can derive from products as explained by Lai, Dittmar's (1992) symbolic-communication model is believed to be relevant as it provides a basis for understanding the potential symbol-bearing meaning users can ascribe to products, such as symbolic mediators of identity. Monö's product semantic framework revolves around the idea of the product communicating a message and the user as the receiver of the same message, interpreting, understanding and responding to it. Considering the focus of this licentiate thesis, i.e., to investigate and compare different user categories' needs for an AT product and their relevance for users' acceptance, Monö's trinity model and semantic functions are considered an appropriate basis as it provides a broader view of how users perceive, evaluate and make sense of a product, building on its different product features influencing users'

responses to a product. Some of Lai's benefits could be considered represented in the trinity model, for example, Lai's *functional benefits* relate to Monö's *ergonomic and technical whole*, and Lai's *aesthetic and social benefits* relate to Monö's *communicative whole*. However, other benefits such as *affective benefits* (i.e., a product's ability to evoke emotions), *epistemic benefits* (i.e., a product's ability to provide novelty and satisfy curiosity) and *situational benefits* (a product's ability to meet specific needs in specific circumstances) are not specifically represented in Monö's model. Monö provides explanations for how users respond to a product gestalt based on how a user translates and interprets the transmitted message created by the semantic functions, resulting in understanding, emotional responses and actions. However, Monö does not specifically define possible affective, epistemic or situational benefits that users can derive from products. Thus, Lai's generic product benefits can provide an additional layer to explore how users perceive products and the benefits they can derive from them. This could influence which needs for ATs they experience as necessary to be fulfilled as prerequisites for their acceptance of ATs. An additional dimension of how people perceive products is provided by Jordan's *product pleasure framework* (2000), in which he defines possible pleasures that product characteristics (beyond function-based characteristics) can evoke. Both Monö's and Lai's frameworks can to some extent be considered to be represented in Jordan's *pleasure framework*, building on the idea that user's interactions with products elicit feelings. This view is also partly described and represented in Lai's generic benefits, i.e., *the affective and hedonic benefits*. Monö includes emotional responses to products depending on how the product gestalt is understood by the user, which can result in emotions/feelings. Furthermore, Jordan's *ideo-pleasure* can to some extent be considered to be represented in Lai's *aesthetic benefits* and by Monö's *communicative whole*. In addition, Jordan's *physio-pleasure* (refers to product characteristics eliciting bodily experiences) is included in Monö's *ergonomic whole* and in Lai's *functional benefits*. Jordan's *socio-pleasure* characteristics (associated with feelings evoked of enjoyment and connection to others) are described by Lai in his *socio-benefits* and Jordan's *psycho-pleasure* (elicit cognitive and emotional reactions) is represented in Monö's *ergonomic whole*. Additionally, Lai's concrete *functional benefits*

can be compared with Jordan's basic needs in his hierarchy of consumer needs, as well as with his *psycho-pleasure* characteristics, and with Monö's *communicative whole*. Nevertheless, Jordan's framework is a useful complement to Monö's model and Lai's generic framework as it defines specific pleasures that a product can (and should) evoke in users and which can impact their willingness to accept and adopt products such as AT aids.

Although there are similarities and differences between these selected theories and models, the focus when investigating AT users' needs, their preconditions for acceptance and reasons for non-use will be on the structure of Monö's model. The reason for choosing Monö's framework as the main theory is that it is developed from a design perspective, and thus includes a broad view of different aspects of products that each individually and together influence the user's response to a product gestalt as a whole.

### 3 Research process

A conceptual design project was carried out with the intention to design a new, individual mobility AT transfer device. The goal was to support or enable short-distance transfer situations indoors to enhance mobility, accessibility and independence for users in need of transfer devices, and/or to support people helping them. The design project included two user studies with intended end-users. These studies were used as background material, i.e., as a case study to investigate user needs and to discuss and seek answers to the research questions and hereby contribute to the overarching aim of the research. Users from four different categories were included, i.e., individuals with physical mobility impairment, hospital staff, professional home health caregivers and relatives as care providers were interviewed on two separate occasions.

The decision to use the design project as the basis for the research evolved after the design project was established and project funding was approved. Therefore, the user studies were planned within the setting of the design project. Prior studies have described AT development as framed by a problem-solving perspective (Pullin, 2009). The design project described in this thesis can also be described to have been framed by such a problem-solving perspective. Thus, a possible argument against the research being carried out within the design project is that data collection was shaped by the purpose of the design project (i.e., to support independence) instead of exploring users' needs per se, and if and how these needs can be fulfilled by different AT solutions. Nevertheless, the information elicited in the user studies was considered to be a good basis to investigate AT users' needs in more depth. Hence, the data collected from the user studies constitutes the empirical research data. Furthermore, the research was carried out within the context of the design project and can be described as *research through design* (RtD) (e.g., Forlizzi et al., 2009; Zimmerman et al., 2007). RtD can be defined as a research approach that uses the methods and processes from design practice as methods of inquiry to generate new knowledge. That is, the design project that encompassed the design process of

designing a mobility AT transfer device with user studies was used as a research method to investigate and understand AT user needs in more depth.

### 3.1 The design project

The design project was financed by a governmental funding body, Vinnova (or the Swedish Agency for Innovation Systems), through an open-call application process for industries and universities to seek funding for development of an idea to result in a prototype suitable for commercialization in collaboration with health care service organisations or providers. Conditions for getting financial support for the project were to present a cost-effective, innovative and use(r)-centred proposal that included intended end-users to meet the daily needs of a growing population of seniors to live independent lives regardless of age-related impairment or disability. Therefore, the project was carried out through a university affiliation<sup>1</sup>, in collaboration with partners representing industry (providing tests, construction and prototypes) and partners representing healthcare service organizations. The latter provided most of the participants representing the intended end-users, i.e., people with impairment and disability, who participated in the user studies and provided information on user needs, as well as feedback on and evaluation of design proposals. Clinical trials were not to be included in the project. Such trials, which are conducted in the actual use environment and over time, were to be carried out at a later stage, after the necessary approvals. Additionally, project funding was to result in a developed, tested and evaluated functional prototype, which was to be adapted to a cost-effective production method and suitable for further investment, with the main goal being commercialization.

In order to be considered for funding, an initial design proposal was required to be presented in a visual format, along with detailed information on realization including functionality, technical components and production method. Furthermore, basic

<sup>1</sup> Institute for Management of Innovation and Technology (IMIT)

functions and technical components had to be pre-tested before any decision on financial support was taken. Therefore, a set of fixed conditions such as definition of use situations, functions, technical components, battery capacity, motorized wheels, material, and production method were formulated, purchased, and partly tested at the beginning of the project – before the user studies were conducted. The intention was to modify and further develop the AT design concept based on the user feedback provided in the user studies, with the purpose of improving preconditions for user acceptance.

The conceptual AT design project was based on the idea of developing a device that was aesthetic, multifunctional, and user-friendly. Compared to prior individual, short-distance, mobility AT transfer devices such as sling lifts, which are often large, heavy, and require two or more persons to carry out a transfer, the new conceptual mobility AT device was small-sized, lightweight and equipped with electrically powered wheels, constructed and designed to be operated by one person, i.e., the person in need of a transfer and/or the person supporting the transfer. The predefined design criteria are provided in a product map, see Figure 6.

The AT with its new functions were thought to enhance and support accessibility and independence for a person in need of the transfer, as well as for any helper to carry out transfers in different indoor situations, such as from and to bed, wheelchair, chair, shower, and toilet.

## Functional properties

### Multifunctional;

- ability to adjust the seat to different body sizes
- offering different seat options; traditional chair sitting position sitting astride i.e., one leg on each side of the seat
- function in transfer situations indoors; from and to bed, wheelchair, chair, shower, and toilet

### User-friendly;

- have electrically powered wheels to minimize physical force needed to push and pull the device
- be small in size,
- be lightweight;  
able to be disassembled into two units 10 kg each plus battery pack 2.6 kg)
- able to be operated by one person by a set of two optional power handlebars
- individual adjustment of seat position and seat height by regulating the wheelbase in a kneeling and stretching function



## Technical components

- motorised wheels
- rechargeable batteries
- electrical functions to operate speed/brake and seat position
- actuators to regulate the extension of the wheelbase

## Aesthetics;

### Pleasing appearance;

- hide technical solutions to accentuate the shape and emphasise a user-friendly impression
- look multifunctional
- look agile and smooth
- express lightness
- express mobility

Figure 6. Product map

The accomplishment of the project involved several phases (see Figure 7) and challenges, from construction of functions, production of drawings, analysis of needs, demand and risks, selection of technical components, tests of functions and production method, seeking partners, planning, and conducting user studies, modifying the concept according to user input, and producing and evaluating a physical prototype.

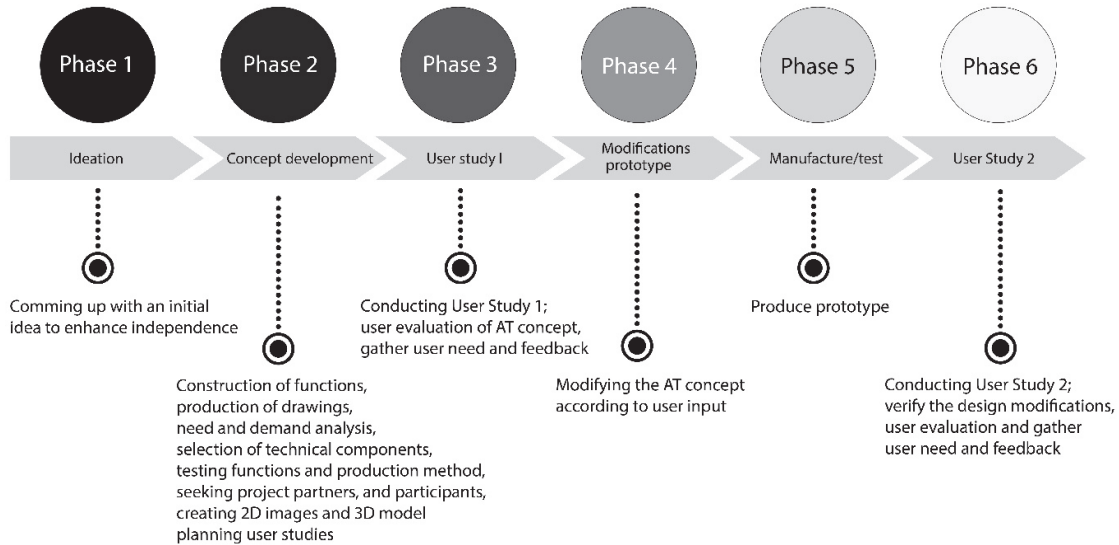


Figure 7. Different phases of the design project

### 3.2 The research structure

The overall aim guiding the research, i.e. *how to design AT for acceptance and adoption*, was broken down into research questions and ways in which the questions could be answered.

The first user study, User Study 1, can be described as primarily explorative, i.e., the purpose was to get first-hand information about how the four different user categories perceived and responded to a specific AT device; what needs they described, if any needs were similar or differed, and if any need(s) was emphasized or more critical than others. The information was gathered through semi-structured interviews. The analysis from this first study affected and steered the process of the second user study.

Compared to User Study 1, User Study 2 had a more focused approach, i.e., collecting more in-depth information about how the participants in the different categories perceived and valued the AT in terms of its overall appearance, aesthetics and meaning. For this purpose, guided by the findings from User Study 1, an additional method was used to complement the semi-structured interviews used in both studies.

The method included a Semantic Differential Questionnaire (SDQ) supported by product representations (PRs) and illustrations of different use situations. The SDQ was structured according to four main themes including functional and 'soft' product aspects, such as aesthetics and meaning, and emotional aspects. In addition, the participants were asked to consider to what degree the design 'fit' different use environments. This part of the research process can to some extent relate to the process of Grounded Theory (Glaser and Strauss, 1968) in terms of an ongoing analysis process guiding the next research phase but was not regarded to form new theories.

To address the overall research aim guiding the research, that is "*how to design AT for acceptance and adoption,*" research questions were formulated and guided an initial analysis of the results of the two empirical user studies. The insights from the two studies were then analysed in relation to the frame of reference, in particular to Monö's product semantics framework, to gain a deeper understanding of four different user categories' needs for an assistive technology (AT) mobility transfer device based on their responses to and comments on the conceptual design of the AT. Their needs were reflected on in relation to their significance for acceptance and use. For an overview of the structure of the design project and the research process, see Figure 8.

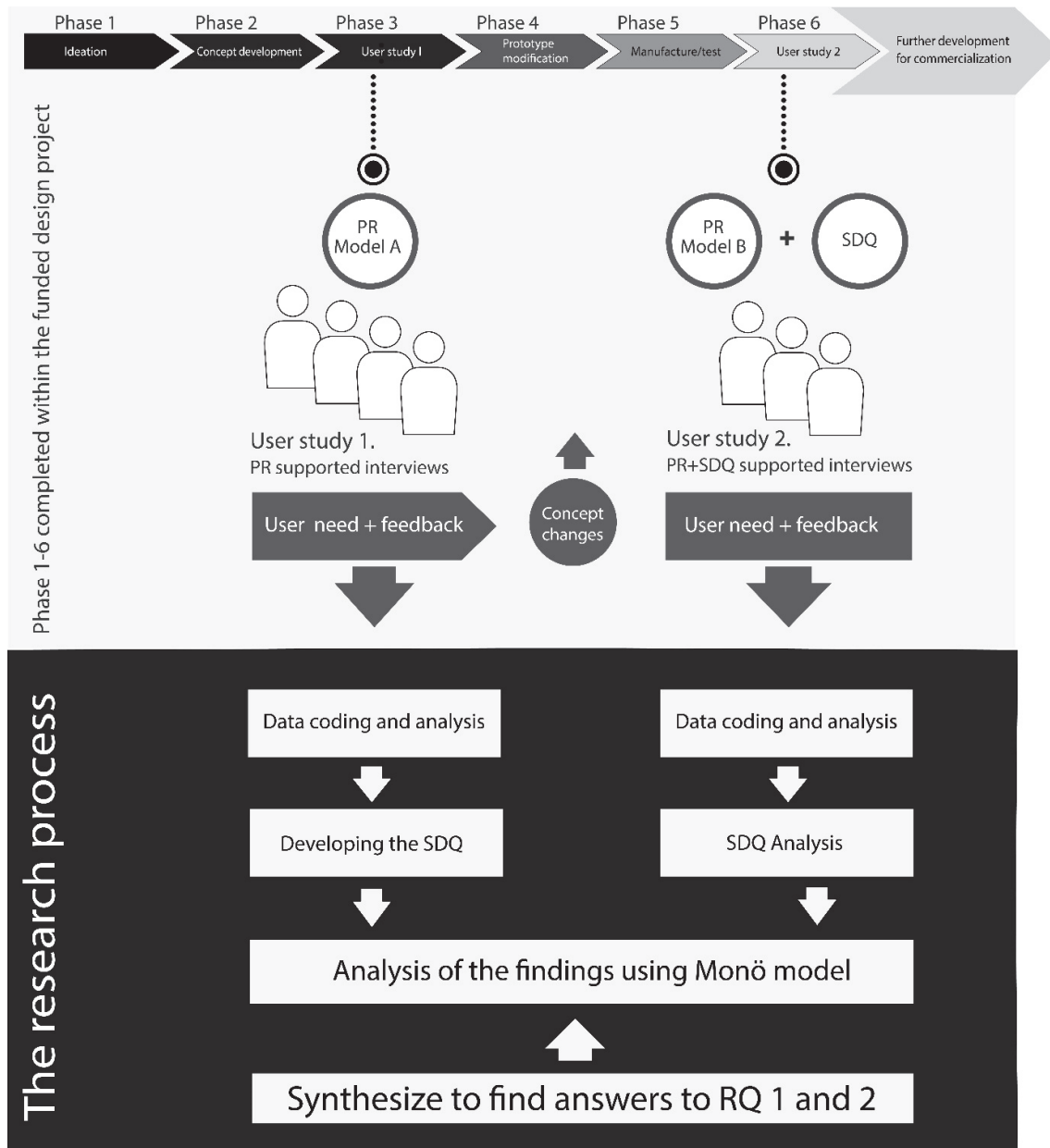


Figure 8. The research process within the design project.

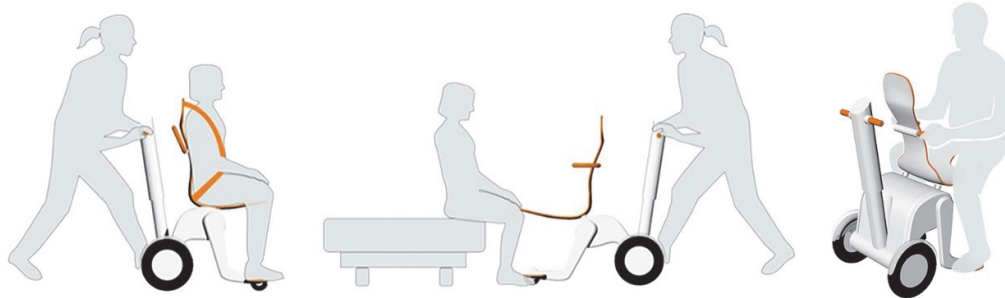
## 4 User studies

### 4.1 Overall approach

With the purpose of obtaining user feedback on the conceptual AT and developing the design according to the information provided by the intended users, information on their needs had to be gathered. Semi-structured and unstructured interviews are considered valid qualitative methods to elicit user information (Brinkmann, 2014). The purpose of gathering information on needs and obtaining input on specific questions motivated the choice of semi-structured rather than unstructured interviews. Thus, the empirical data that was gathered in the user studies was elicited using open-ended, face-to-face, semi-structured interviews, supported by different visual product representations (PRs). The open-ended questions provided the opportunity for the participants to reflect on specific needs, and to describe additional needs, wishes or problems in their own words (cf. Brinkmann, 2014; Kvale and Brinkmann, 2015). In addition, it provided an opportunity for the interviewer to ask more in-depth, follow-up questions, add questions and structure the sequence of the questions based on how the participant responded to facilitate a natural conversation and transition between different questions (ibid.).

Consumers' responses to and judgements of products are often based on a product's visual information; the visual appearance is considered a decisive factor in their responses (Crilly et al., 2004). Thus, all interviews were supported by 2D visualizations (made from 3D CAD models) of the conceptual AT transfer device for the participants to respond to and evaluate. The visualisations included information about use situations, functions, size and weight (the two latter supported by text information), and five different transfer situations from and to: i) bed, ii) wheelchair, iii) chair, iv) shower, and v) toilet. Some illustrations showed a person standing behind the device operating and driving it by means of a set of handlebars on a rod bar/pole, and a person sitting with his/her back against a backrest, while other illustrations showed a person sitting astride the seat, operating and steering the device with an additional set

of handlebars (Image 1). All visualizations and illustrations that were used as PRs were shown on a tablet screen placed in front of the participants.



*Image 1. A person sitting on the device and being transferred to or from bed and sitting astride.*

In addition to providing information on their needs, in both user studies, the participants were asked to evaluate and give feedback on the AT design based on their personal experiences, situations, and context of use. In User Study 1, the participants responded to the initial AT concept, i.e., model A (see Images 1-2). Based on the participants' feedback this initial concept (model A) was modified, resulting in a new concept (model B) (see Image 3), which was used as input in User Study 2.



*Image 2. Initial AT concept, i.e., model A with an integrated socket in the seat.*

The two user studies included a total of 36 face-to-face interviews that were carried out by the author, who was also the designer of the conceptual AT (Images 1- 3). The interviews took place at a location according to the respective participant's preferences. Consequently, the environments for the interviews varied between

private homes, cafeterias, offices, home care units and hospital wards. The interviews lasted between 30 and 45 minutes and were carried out in Swedish<sup>2</sup>. In addition to written notes, the interviews were audio-recorded and later transcribed verbatim. All the participants participated voluntarily with verbal consent. They were all informed that they could withdraw at any time without explanation or consequences. The data was collected and stored so that individual privacy has been secured and in compliance with GDPR<sup>3</sup> laws.

The following chapter summarises the information elicited in User Study 1 and User Study 2.

## 4.2 User Study 1

### 4.2.1 Aim

The aim of the first user study was to gather information on user needs from four different categories of intended users and for the users to evaluate and give feedback on the conceptual AT design (model A).

### 4.2.2 Method

#### 4.2.2.1 Interviews

The interviews followed a generic procedure with an introduction in which the project purpose and goals were presented (i.e., to modify the concept based on users' feedback with the goal to produce a prototype suitable for commercialization). After the introduction, the participants were interviewed and asked to give feedback on model A and describe their needs and wishes in relation to the AT. More specifically, they were encouraged to reflect and describe their impressions of the AT device, its

<sup>2</sup> For the thesis including papers 1 and 2, all interviews have been translated from Swedish to English.

<sup>3</sup> Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data and repealing Directive 95/46/EC (General Data Protection Regulation). *Official Journal of the European Union* L 119 4 May 2016; 1–88.

functionality, usability and appearance, and to provide information on any additional problems they perceived with the design, as well as ideas for improvements or changes to the design. They were also asked to describe if and how they were likely to carry out transfers in the five different transfer situations that were shown and how, they thought that the conceptual AT device would enable their independence. After each interview question, the participants were given time to reflect on the question and elaborate on their answer before the next question was asked. They were also encouraged to further describe their impressions and thoughts through follow-up, probing questions. When the last question was asked, each participant was given the opportunity to add further comments on needs, requirements, wishes, etc.

#### 4.2.2.2 Participants

Participants were recruited to represent future users of the AT. The purpose was to obtain information from different user categories on their experiences, domain knowledge, situations, and roles in relation to using or needing a mobility transfer AT aid. Twenty-one participants representing four user groups took part in the study (Table 1).

Table 1. User Study 1 involved a total of 21 participants, aged between 30 and 83 years old.

	Category	Men	Women
A	Users with physical mobility impairment	3	4
B	Relatives as care givers	2	1
C	Home care givers	2	6
D	Hospital nursing staff	2	0
D	Occupational therapist	0	1

The four user categories were:

- a) individuals with physical mobility impairments, all experienced users of AT such as wheelchairs for transportation and/or sling lifts and sliding boards, etc., for transfers;
- b) senior relatives as informal caregivers of relatives with an impairment or disability in need of wheelchairs for transportation and/or sling lifts and sliding boards, etc., for transfers;

- c) professional home health caregivers, providing support to individuals in need of support for transport and/or transfers, most of whom had experience using several AT transfer solutions; and
- d) orthopaedic ward hospital staff providing support for transportation and transfers of patients staying at the orthopaedic ward, and who also had experience using several AT transfer solutions.

Participants from the three latter categories were provided by corporate project partners representing healthcare service organizations. The participants with mobility disabilities and/or impairments were limited to people living in the municipalities of Gothenburg or Mölndal, on the west coast of Sweden. They were recruited via social media and e-mail. All individuals who were asked and who agreed to participate were included.

#### 4.2.2.3 *Analysis*

A content analysis was performed on the collected interview data. The analysis omitted information that was considered to not relate to user needs for AT or did not include information on any subjective experiences. The choice of using content analysis was to systematically organize the interview transcripts to determine the presence of specific terms, meanings, and relationships between terms and to organize the information based on users' roles and situations, i.e., 'who said what.' The process included carefully reading the transcripts to become familiar with the data, memo writing and reading the transcripts with coding of individual keywords, sentences and paragraphs related to needs and use experiences. The codes were then compared in order to identify categories/themes. The process was inspired by Miles and Huberman's (1994) three-stage approach of data reduction, initial coding, and search for themes. The coding process was drawn from a bottom-up approach, i.e., codes were derived from the data, in some parts participants' own words were used, i.e., in vivo codes. In order to identify common and/or varying needs the codes were compared within each user category and between the different user categories. The

main categories that emerged were 'aesthetics', 'emotional reactions', 'identity', 'exposure/security', 'efficiency/functionality', and a category for other aspects.

#### 4.2.3 Findings

**Group A.** Some of the participants thought that the device would be useful to achieve or support independence and that it could facilitate transfers and reduce any physical strain associated with transfers. Other participants did not consider it useful for this purpose. They thought it would stand in the way when they used their wheelchairs and other devices to transfer.

The motorised wheels were perceived as functional to enable independence with less physical effort – *“One does not always have the strength and energy to do all those transfers...”* // (Female, Group A), although safety concerns were raised – *“If the wheels are power driven, then it is even more important to offer protection because otherwise one might bang hard into a doorframe.”* (Female, Group A). Some of the participants saw a value in being able to operate the device and manage transfers themselves but only if the device was further developed with additional functions such as an extra transfer sliding-board, foldable backrest, adjustable arm- and footrests, etc. However, others thought that they would still need human support to transfer safely. *“... It would be nice to operate it independently ...//... I would, however, feel safer to operate it with support by a caregiver.”* (Female, Group A). Personal hygiene situations were specifically pointed out as situations where independence was important.

Some participants perceived the astride sitting position to be positive as it provided the possibility to have eye contact with a helper, but negative emotions and concerns were also voiced as they felt they would be exposed by the device and that it could infringe on their integrity. The integrated socket in the seat (Image 1) triggered the feeling of being exposed – *“I hate it when they have those holes in the seat! It’s very exposing.”* (Female, Group A). Some also perceived the astride position to be odd and

uncomfortable – *"It looks unbalanced and unpleasant to sit astride on; it feels very strange."*; *"A forklift feeling...."* (Female, Group A).

Most of the participants from Group A expressed that they felt their needs for aesthetics of AT products were in general not prioritized. They thought that most AT products were *"un-designed"*, *"engineered looking"* and *"stigmatizing"*. They all expressed a need for AT designs that were *"dignified"*, *"appealing"* and *"aesthetically pleasing"*, and which symbolized *"the right thing"* such as a *"cool"*, but also *"unusual"* look as this could elicit curiosity and desire – *"Transparent is pretty cool too, when you see everything ... // ... then you put some cheeky lamps in the electronics you can do too, so it shines and looks a little spaced and so ..."* (Male, Group A). They also experienced that they had no say in the matter of what AT product they were offered but had to accept a standardized version, i.e., a *"... take it or leave it"* situation was expressed. They all valued independence, nevertheless, they had rejected prior AT products not only due to poor functionality but also because of appearance.

Their impression of the presented concept (model A) varied from being perceived as *'well designed'*, *"modern"* *"nice"*, *"clever"* and *"cool"* and to bear a resemblance to the famous design chair *Myran*<sup>4</sup> with *"soft and clean"* lines, but also to look *"heavy"*, *"unstable"*, *"unsafe"* and odd, with a *"a forklift feeling"*, and just a new version of a previous product, as an *"updated shower chair."* Most participants wanted to be able to choose the colour of the device, and some wanted to be able to also choose decorative details with the purpose of making the AT *"personal."* In addition, a need for the AT device to *"melt into"* the environment was expressed.

In summary, several of the participants in this group perceived prior mobility aids, which they relied on for transport and transfers on an everyday basis (e.g., private, work, and social contexts) to be un-designed, ugly, and stigmatizing. They felt that

<sup>4</sup> Refers to the chair *Myran*, produced by Fritz Hansen, and designed in 1952 by the architect and designer Arne Jacobsen.

they had no influence on what aids they were offered and that their aesthetic needs for these aids were not prioritized. The results showed that the overall functionality, usability, comfort, and safety aspects were important and related needs were described in detail. AT aesthetics were judged to be as important as functionality and accessibility for acceptance but more detailed information on aesthetics and related needs was not offered. In addition, some functions intended to enhance independence, usability, and accessibility evoked negative emotions as they were perceived to be too unpleasant.

**Group B.** The relatives as informal caregivers described that the transfer mobility solutions they had been offered did not meet their expectations or their needs. For example, one participant described how his wife had received a hygiene chair for toilet visits to stand by the bed to facilitate toilet visits and rollators and walkers to support and/or facilitate transfers but that these solutions were neither sufficient, nor safe as his wife lacked the necessary balance and strength to use them as intended. Instead, he helped his wife to transfer whenever needed. He estimated that he helped with 20 daily transfers between wheelchair, bed, sofa, armchair and toilet seat etc. Another participant, who managed many of the daily transfers that his wife needed, described how he had been instructed to call for help when transfers were required between bed, toilet and wheelchair. The same situation was described by another participant caring for her husband. Thus, in transfer situations, partly due to age-related physical changes (such as reduced mobility and strength), some of the informal caregivers had to rely on getting help around the clock from home health care givers who accommodated transfers for the relative who needed transfers. They described this to be wearisome from time to time as they felt that their privacy was invaded - *“Saturday and Sunday, we have time off, I say. I can’t bear them being here so much, you get so tired of it, your home is not just yours.”* (Female, Group B). They were nevertheless grateful for being helped as they sometimes felt they lacked the necessary physical strength to help their relatives.

They considered the ability to operate the device smoothly in narrow environments as very important as space was often limited in their home environments. Efficiency was also mentioned as important as repeated transfers were carried out on a daily basis. They valued independence and appreciated the possibility to operate the device by themselves. Nevertheless, they felt uncertain and did not believe they would be able to operate the device independently, mainly because of safety concerns and lack of physical strength. Transfers to and from the seat of the device were perceived as difficult, as was the astride sitting function – *“It is not the ride that is problematic, it’s the transfers.”* (Male, Group B). Furthermore, functions other than those that were presented in the PRs were requested, such as functions helping them to assist in dressing and undressing situations. However, they did not comment on the appearance of the design if not specifically asked to do so. When asked to describe how they perceived the appearance they responded that it looked *“nice”* and *“neat.”*

To sum up, the informal caregivers were hesitant to use a transfer device such as model A, mainly due to lack of strength, and anticipated problems with operating it and helping their relatives get on and off the seat of the device. The size of the device was judged to be fit for use in their homes. Functionality and safety were emphasized as important, and these aspects and related needs were described in detail. Requests for additional functions were voiced. Compared with the participants in Group A, the participants in this group were less familiar with using different types of ATs.

**Group C.** The home health caregivers perceived the device to be *“useful for its purpose”* and its multifunctionality, with the ability to adjust the seat to different body sizes and alternative astride seating positions, was considered to be useful and further that it could prevent work-related injuries. This sitting alternative was believed to be efficient by the majority in this group as it would *“simplify”* hygiene situations, while others thought this position to be unpleasant and difficult for seniors in need of transfers due to pain and stiffness. In addition, the size of the device was believed to be beneficial as it enabled use in narrow environments such as the care recipients’ bathrooms and

bedrooms. The possibility for one person to operate the device was evaluated as positive as this would increase efficiency, i.e., *"save time"* and resources. However, several of the participants in this group thought that they still needed to be two persons to carry out any transfer situations safely even with the use of the device. They described that this was how they had been trained and instructed, i.e., to be two staff whenever a transfer took place. Furthermore, transfers to and from the seat of the device were mentioned as problematic and some expressed a fear that the device would overturn. Padding and cushioning were requested as were additional functions, for example, a tilt restrain function to prevent the device from overturning, and a function providing support when assisting in dressing and undressing. The majority did not comment on the appearance of the design if not asked specifically to do so. Then some of them responded that they thought that the device looked *"nice"* and *"neat"* and that it looked *"suited for its purpose"* and *"professional."*

In summary, like Groups A and B, participants in Group C perceived overall functionality, usability, and security aspects as central and related needs were described in detail. Comfort aspects and related needs for themselves and for the care recipients for whom they provided help were also described, while aesthetics aspects were not specifically commented on. Similar to participants in Group B, problems were described transferring a person to/from the device seat and the need for additional functions for supporting dressing/undressing.

**Group D.** The hospital staff evaluated the conceptual design primarily based on how they perceived that it would affect patients' safety. They believed the motorised wheels and the size of the device to be functional and fit for use in narrow spaces in their work environment, such as patients' rooms and bathrooms. The possibility for one person to operate the AT was perceived to be functional, efficient and to reduce work-related injuries, as were the different sitting options. Some of them saw a value in that both patient and staff could use and operate the device independently, although some described that being two or more personnel if needed when transferring patients was

the way they had been taught for safety reasons. Furthermore, they requested that the sitting comfort for the patient was further developed with padding and cushioning. When asked to comment on the product's appearance they responded that it looked *"smart", "clever", "professional"* and appeared *"easy to use."*

Like Groups A, B and C, the participants in Group D also perceived overall functionality and usability aspects to be important and needs related to these aspects were described in more detail. Patient safety and comfort were emphasized to be the most important aspects and needs were described in detail. Independence and ergonomic functions were evaluated as beneficial, both to carry out work tasks and for patient comfort. Despite these potential benefits, the participants in Group D judged that they still needed to be two or more staff to carry out transfers safely. This was also how they had been trained to perform patient transfers.

#### 4.2.4 Conclusions and implications

AT users are not a homogeneous group but belong to different user groups with different roles, situations and contexts of use affecting their evaluation and response to ATs and what further aspects of the AT they comment on and what needs they describe. The semi-structured interviews supported by PRs were considered useful for eliciting and gathering information from participants in all user groups about their needs for an AT. The analysis was helpful in gaining a clear understanding of the collected information and in comparing the information provided by the different user groups to identify common and different needs. Functionality, usability, and safety needs were described by all participants as important to consider for accepting and using such a device. The aesthetics were mainly commented on by participants in Group A as important to accept and feel comfortable using such a device. They also described conflicting needs in relation to the appearance of the AT, such as wanting it to fit into their homes, to be discrete and not elicit attention, but also wishing it to be 'cool', symbolise the 'right thing', be 'dignified' and 'modern' and to elicit positive attention from others, thus defying their prior experience of ATs as stigmatizing.

However, some of the participants in the primary user group (Group A) feared being stigmatized by the AT infringing on identity. Although these softer aspects of the AT were emphasized as important, they were not described in any depth or detail. The participants from the other user groups did not mention the aesthetic aspect of the AT if not specifically asked to do so, indicating that related needs were either not important to all user groups, and/or that they were difficult for the participants to describe. Furthermore, functions aimed at supporting independence, such as the astride sitting position, were evaluated by participants in Group A not only in relation to their functionality, usability and safety needs but also in terms of emotional experience. From this perspective, the device was perceived to be too exposing. The participants in Groups B, C and D did not respond emotionally to the astride sitting function, and some perceived it to be functional and efficient.

In summary, the findings indicate conflicts between users within the same user group and between different groups. For example, while all participants in the different groups valued basic functional and safety needs as important for AT acceptance and use, design features that communicated these properties were assigned meanings other than those primarily intended. That is, functions that were perceived as efficient by the professional caregivers in Groups C and D were perceived as exposing by participants in Group A, which imposed conflicting requirements on the design. For example, a design that meets users' basic, functional needs for an AT can be accepted by users in one context of use while at the same time being rejected by other users in another context because the design can be perceived to be too exposing or engineered looking. Still, without fulfilling basic functional needs it is difficult (or impossible) to address the emotional aspects of design, hereby challenging the designer's task to fulfil users' needs. Moreover, more detailed information was needed from all participants on how they perceived the AT's aesthetic qualities, the meaning they ascribed to it, as well as how the AT made them feel. Therefore, it was considered necessary to investigate whether these softer aspects and related needs were only relevant to one specific category of user (i.e., Group A) or if they also applied to the other user

categories (i.e., Groups B, C and D) as well. The interpretation was that another, complementary data collection method was called for. Hence, a method problem was identified.

### 4.3 Intermediate step: Developing the SDQ

With the purpose of gathering more information on how the participants perceived the AT's aesthetics, what meanings were evoked and the users' emotional reactions, it was decided to develop a questionnaire to prompt all participants to reflect on softer aspects of the AT. Thus, a semantic differential scale (cf. Osgood et al., 1957) was developed. The semantic differential scale was originally an instrument used to measure meaning of objects but nowadays is used to measure a wide variety of topics, including attitudes, perceptions, etc.

The most frequently mentioned adjectives used to describe the AT were extracted from the interview transcripts from User Study 1 and grouped into categories according to similarity. Bi-polar adjectives were then chosen with respect to the product category and target group as proposed by Wikström (2002). The categories that emerged were similar to the categories developed in the content analysis, i.e., five themes were identified: i) aesthetics, ii) emotional responses, (iii) functionality, and iv) meaning. A further aspect was added concerning context of use; v) how the product was perceived to fit different use environments. The different use environments were shown in photos of three different bathrooms, i.e., in a private home, in a healthcare facility, and in a hospital.

## 4.4 User Study 2

### 4.4.1 Aim

The aim of the second study was to evaluate a modified version of the conceptual AT design (model B, Image 3) and to gather further information on users' needs, in particular information on aesthetics, meaning and emotional aspects.

## 4.4.2 Method

### 4.4.2.1 Interviews and questionnaires

The first part of the second user study followed the same structure as the first user study, i.e., open-ended, semi-structured, face-to-face interviews supported by visual PRs, these being the modified AT (i.e., model B, Image 3) and illustrations of different use situations i.e., the same five transfer situations as in User Study 1, but based on model B. The interview questions initially focused on functionality, usability, and appearance. The participants were asked to evaluate the AT concept and give their input based on their needs, to describe if/how they would carry out the transfers shown and any problems they perceived, and further if/how they thought that the device would enable independence. They were also asked to suggest improvements or changes to the AT. The participants were also given the opportunity to add any comments on needs, requirements and wishes at the end of the interview session.

To elicit more in-depth information on softer design aspects from all participants, they were then asked to answer the SDQ (pen on paper). The visual PRs of model B that were shown in the interviews supported the participants also when answering the SDQ. The reason for this structure of gathering information was that some of the participants in User Study 2 had also participated in User Study 1, while others were new participants. Thus, in order for the SDQ to be answered based on similar conditions, the participants were given the SDQ to answer after the interviews.

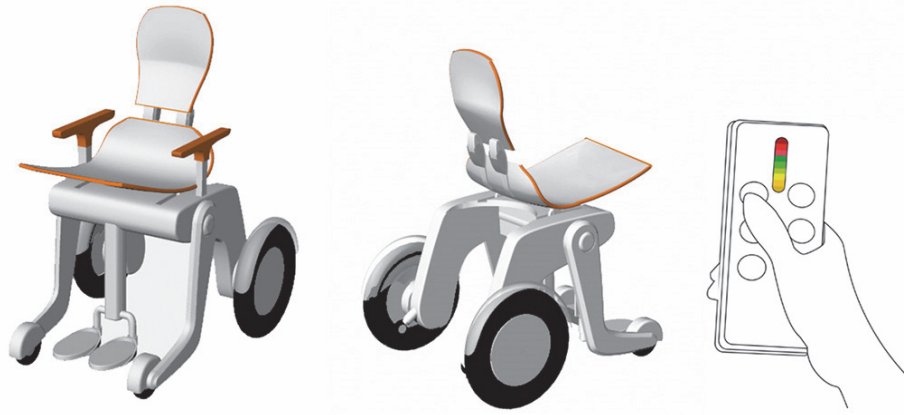


Image 3. Modified AT concept, i.e., model B.

#### 4.4.2.2 Participants

Fifteen participants took part in the second user study (Table 3). The individuals in Group A were the same as in User Study 1 whereas some of the participants from Groups C and D were the same individuals as in the former study. The category encompassing relatives as informal caregivers, i.e., Group B, did not participate in the second user study due to difficulties in recruiting them.

Table 3. User Study 2 involved a total of 15 intended users as participants, aged between 30 to 65 years old.

Category	Men	Women
Primary users with physical disabilities	2	3
Home care giver	2	4
Hospital nursing staff	2	1
Occupational therapist	0	1

#### 4.4.2.3 Analysis

All interviews were transcribed and analysed in the same way as in User Study 1. Information and statements that did not include any information on user needs or subjective experiences in relation to AT aids were omitted. The transcripts were carefully read and initially coded, followed by a systematic reading of the transcript with a coding process based on user needs. The coded contents were compared within and between the categories to identify common and/or different needs and to find meaningful patterns. The identified categories were similar to those developed in the

previous analysis process, i.e., aesthetics, emotional aspects, identity, exposure/security, efficiency/function, and a category for other unspecific aspects (i.e., not fitting into any of the identified categories). Questionnaire data was summarised, and median values were calculated for each item and for each of the user categories, in this case, primary users (Group A) and personnel (Groups C-D).

#### 4.4.3 Findings

Similarly to the prior study, instrumental needs, i.e., needs related to functionality, safety, and usability, were emphasised by all user categories.

For Group C and Group D, the device was perceived mainly as work equipment. The participants focused their comments on functionality, safety, and efficiency aspects – *“Bathrooms are not that big”//... (Male, Group C)* and – *“It is tight ...//... So, if you manoeuvre a big lift in it, is also not optimal.” (Male, Group C)*. They perceived the device’s size, the possibility to adjust the seat (to fit different body sizes) and seat height, the additional tilt restraining function and operating choices (steering handles and handheld remote) to look efficient – *“I feel equipped.” (Female, Group C)* *“Because many of the shower chairs we have now, they’re not that big, but it’s like driving a full ICA trolley and it’s like, it’s not possible to turn.” (Female, Group C)*. As in the first study, some of the participants expressed needs for supporting dressing and undressing and concerns were again raised about safety aspects, such as if the AT would be stable enough and not overturn, and regarding battery or technical failures/malfunctions.

Participants in Group A responded to the AT as a device to support independence in their homes. They perceived certain benefits in terms of the small size of the device – *“Bathrooms are often quite cramped.” (Female, Group A)*. However, the participants in this group had the same safety concerns as those expressed by Groups C and D. As in User Study 1, some of the participants perceived that using such a device with its motorized wheels, and electrically adjustable seat height would result in fewer transfers and reduce physical strain. However, participants in this category evaluated these aspects

not only in terms of functional and safety but also in relation their possibilities for increased accessibility and independence. Some of them thought it could be useful to increase accessibility and independence in other situations than the five use situations presented, such as on the beach and in the water. In addition, they evaluated functions on the basis of identity. For example, one participant commented on the cordless, handheld remote control intended to increase independence and mobility - *'I like remote controls and so on. I think it's a bit of fun, ah you know it's manly, like me, a whole row of remote controls.'* (Male, Group A). Another comment from the same participant concerned the tilt restraint function intended to prevent the device and the person sitting on it from falling backwards - *'This is a "chicken" version, I don't operate like that.'*

Furthermore, participants in Group A commented on aesthetic needs, such as to be able to choose colour, style and add decorative details - *"That there are certain parts that you can perhaps replace depending on what, what preference you have."* Group A participants also commented on how/if the AT device would fit into their home environment. As in the prior study, the participants in Groups C and D did not comment on the aesthetics if not specifically asked to. When asked, they thought the aid looked *"nice"* and *"functional for its purpose."*

The rating result from the SDQ (Figure 9) showed that the participants perceived the AT to express similar values, implying a consensus on how the different user groups perceived and interpreted the product's visual gestalt.

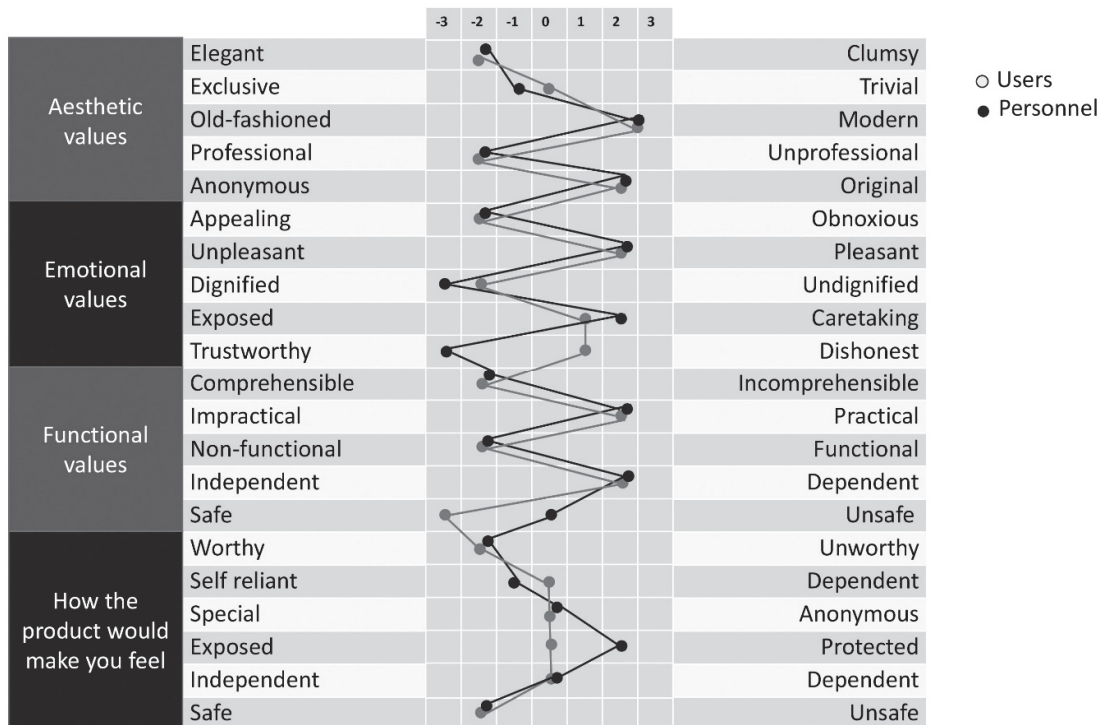


Figure 9. Responses to the SDQ. Median values for primary users (n=5) and personnel (n=10).

However, while a majority of the participants in all user groups rated the AT (i.e., model B) as fitting into all three of the presented environments, differences between individuals in the user groups were verbalised. A female user from Group D explained – “If I think that if it (the AT) fits or not in all of these (environments) doesn’t matter.” In contrast, a male user from Group A argued – “So, in my case, I could very well imagine having a thing like that, standing in my home without feeling any more handicapped so to speak.”

Differences were also found in how the AT device would make the participants’ feel. Groups C and D rated “protected” (Figure 9) while Group A’s average rating to the same question was neutral, i.e., neither or. In addition, some of the participants elaborated on their feelings while filling in their responses and also verbalized their motives for their ratings – “It’s just, like, kind of another aid.” (Male, Group C) and “Well, I think that it’s, it’s simple but also slightly futuristic almost ...//... So, I don’t know if I’d use the word exclusive here.” (Male user, Group A). One participant described that the

interview, together with the SDQ and the questions, had affected him emotionally – *“I was touched somehow ...//... The emotional aspects, they are an important thing.”* (Male user, Group C). He also described that many patients rejected using mobility ATs because they were emotionally affected by the thought of having to use, e.g., a wheelchair after an operation, even though it was only for a short time until they recovered from the surgery – *“It’s a little like that, being able to find acceptance in having to sit in one, in a wheelchair.”* (Male user, Group D). However, there were also participants who found it difficult to express their thoughts despite being probed by interview questions and PRs supporting the response to the SDQ – *“What you think in this situation... //...I have my values... //... as a nurse and a fellow human, all these aspects ... //... I know what I think, but it isn’t that easy to put it into words.”* (Male user, Group D).

In summary, participants in Group A evaluated the AT based on their respective roles and situation, using the AT in their home environments, which was reflected in which needs they described and emphasized as important, such as aesthetic qualities, style, identity, meaning and emotional experience of use. Participants in Groups C and D evaluated the AT from their professional roles and use in their work context in which needs related to safety, functionality and efficiency were emphasized, while softer aspects of use or appearance were not specifically mentioned. Thus, similarly to User Study 1, the participants in Groups C and D perceived the AT device as work equipment, while the participants in Group A perceived the device as a tool for increased accessibility and independence within a home environment, but also as an object to reflect a preferred identity and style.

All participants in Group A had participated in the first user study and were therefore familiar with the AT concept and its functions, which may have helped them to develop their thoughts on its appearance further and to reflect and elaborate on needs and aspects beyond functionality. This was also the situation for some of the participants in Groups C and D, which can have impacted their ability to elaborate on functions, efficiency, and appearance.

Moreover, the participants not only rated the aspects presented in the SDQ, but some also explained their ratings and their reflections on the AT in a broader perspective and in relation to other use contexts than those presented. Furthermore, the PR-supported SDQ and interviews evoked some participants in the professional caregiver groups, i.e. Groups C and D, to reflect on the emotional aspects of ATs. This suggests that not only did the SDQ give all participants an opportunity to express their impressions of a specific AT device design, but it also came to function as a trigger for them to deepen their reflections on softer aspects of ATs. However, regardless of the SDQ, some participants still found it difficult to fill in the SDQ and their emotional responses to the AT. This suggests that more stimuli and/or other tools are needed to obtain more in-depth user information about these softer aspects and related needs.

#### 4.4.4 Conclusions and implications

The semi-structured interviews supported by PRs and photos helped the participants to respond to a specific AT design, describe needs and assumed problems, and suggest solutions for the modified AT to fulfil their needs. Besides supporting the interviews, the PRs were also helpful to focus the questions on the specific AT device (model B) and its use situations.

Similarly to User Study 1, the interviews in the second user study elicited rich information concerning the participants' functionality, usability and safety-related needs. Like in the previous study, information on aesthetic needs and emotional concerns was also commented on mainly by participants in Group A. In this second round of interviews, the latter group expanded on potential use areas of the AT and further elaborated on the meaning of the AT in relation to identity.

Compared to the interviews, the SDQ supported by PRs was more effective for gathering information from all participants in the different user groups on softer aspects of the AT's design. While the interviews implied that most professional caregivers, i.e., Groups C and D, did not consider aesthetics and emotional use aspects,

the answers to the SDQ showed consistency in how participants interpreted these aspects, demonstrated in their ratings of product expressions as well as its aesthetics. However, when providing reasons for their ratings, differences were shown between participants within the same group and between the user groups. For example, some professional caregivers communicated that aesthetics were not an important issue and, therefore, rating this aspect was not meaningful. Another participant in the professional category described how the ratings of the SDQ items, together with the PRs and interview had made him aware of the emotional side of using AT, what needs the AT was intended to serve and that it was difficult to describe feelings in relation to the AT and AT use. Participants in the primary user category explained feeling uncertain of the specific meanings of the listed adjectives. Nevertheless, the findings indicate that the PR-supported SDQ was not only useful as a tool for rating what the AT communicated but also as a 'tool' for triggering participants to reflect and elaborate on less tangible aspects of products including, product meaning and emotional aspects of use.

## 5 Addressing the research questions

### 5.1 Addressing RQ1a and RQ1b

Research questions 1a and 1b were formulated as: *(RQ1a) Which needs do users in four user categories have for a mobility AT transfer device?* and *(RQ1b) Which needs (if any) are similar and which differ between these different user categories?*

#### 5.1.1 Identified needs

The framework supports the assumption that a generic list of user needs for products is not limited to functionality but potentially includes, for example, a need for aesthetics (cf. Lai's aesthetic benefit and Jordan's ideo-pleasure), for positive product experiences when interacting and using the product (cf. Jordan's psycho-pleasure), as well as for what the product communicates about itself (cf. Monö, 1997) and about its user (cf. Dittmar, 1992).

The participants, independent of user category, all described what can be described as instrumental functional needs (and subsequent requirements) for a future AT solution, such as a need for *usability* (e.g., understanding how to use and operate the device, maximization of ease of use and minimizing malfunctions, margins for mistakes, etc.), and for *accessibility* (e.g., managing obstacles, adjusting height, fitting in narrow spaces). The instrumental needs were described as being closely linked to, and dependent on, safety needs (e.g., stability, preventing injuries and fall accidents) being met. These needs are all deemed vital for users considering accepting and using such an AT device given their respective roles, situations, and use contexts.

Participants in the primary user category also described aesthetic needs (e.g., individual variations, possibility to choose colour and add-on decorative details, and for the device to be aesthetically pleasing), a need for the product to express certain meanings (e.g., for the AT to be dignified), as well as needs related to emotional aspects of use, such as needs related to personal integrity as well as wanting to feel proud.

These are deemed to be as important as the instrumental needs for primary users to be able to accept this type of aid.

Thus, the findings suggest that users, independent of user category, have similar prerequisites for AT use and acceptance; that their functional and safety needs must be met. However, for primary users' acceptance will only be possible if other 'softer' needs are also met.

#### 5.1.2 Similar needs but different meaning

The participants were invited to describe their needs for the AT based on their respective roles (i.e., as primary users, relatives in their roles as informal users, or as professional caregiving users), situations and contexts of use. These factors, combined with their experience of AT and other products/ technology, their motivation for and purpose of product interaction, their individual qualities (e.g., physical limitations, temperament etc.) and attitudes shaped by norms and values in society (Monö, 1997) influenced their relation to the AT and the nature of the needs they described – to vary from practical and work-oriented aspects to personal and emotional aspects. These same factors also influenced the importance they attributed to the needs they described, as well as what needs were emphasized and why.

For example, for participants in the professional caregiving categories, the AT was perceived as 'work equipment' intended to meet their work-related needs. Therefore, the verbalised needs for functionality, usability, accessibility and safety focused on meeting work ergonomics standards and safety regulations, meant to increase work efficiency and capacity, reduce physical stress, and prevent work-related injuries.

For participants in the primary user category and for participants in the informal user category, the AT was a tool that could potentially provide or increase their independence and mobility at home. Thus, the AT was expected to meet their instrumental needs for accessibility, mobility, and independence, and to reduce

physical stress and fatigue, as well as any risk of injuries. They described similar safety needs as the professional user categories in terms of having their concrete safety needs fulfilled (i.e., to prevent accidents and injuries), but also described the importance of having their subjective need to feel safe fulfilled. Comfort needs were similarly described, i.e., the AT was not only to fulfil physical comfort needs but also to meet their emotionally related comfort needs, such as not being exposed in any way and feeling worthy/dignified. The latter needs were also described in relation to aesthetic needs, the fulfilment of which was emphasized as a precondition for using such an AT device. Their preferences for aesthetics varied from wanting the device to have a neutral look to having a 'cool' extraordinary look and an overall wish for the AT to be visually pleasant and appealing. These needs were expected to be met by the AT's visual appearance and through the possibility to personalize it to match individual style, image and identity, as well as for the device to fit their respective home environments.

This means that even if the same need is communicated, the meaning associated with the need may differ between users from the same user category, as well as between user categories. This may in turn affect expectations of how the need could be fulfilled, i.e., the subsequent requirements for the design solutions.

### 5.1.3 Methodological issues in eliciting information on needs

The participants' experiences of using other transfer ATs were most likely a prerequisite to being able to describe functional needs in detail and for some of them to describe additional needs (e.g., support in dressing/undressing situations), as well as to have evoked some of them to describe negative emotional experiences (e.g., uncomfortable situations) that they wanted the new type of AT to resolve to increase their acceptance of and willingness to use the AT. The primary users' experience of prior AT aids as "ugly", "standardized" and "stigmatizing" is interpreted as a driving force, urging them to emphasize needs for aesthetics to counteract these and any other negative perceptions of ATs and thereby increase conditions for acceptance. That the

participants in the professional caregiver categories did not emphasise aesthetic needs could in a similar way be explained by their experience of aids that they described as work tools. As the lack of aesthetic qualities had not given rise to any perceived use problems, they did not reflect on the new design in terms of aesthetics, or as something to comment on in terms of its aesthetic qualities but merely as a tool to be able to accomplish their work tasks. This was specifically shown in User Study 2 where some of them described feeling indifferent to how the aid looked or if it fitted in different environments – *“It’s just, like, kind of another aid.”* At the same time, some of them described the AT as 'professional', which implies that they perceived the design to communicate some intangible aspects beyond functionality.

An additional factor influencing what needs the participants described can be linked to the problem-solving perspective (cf. Pullin, 2009) that guided the design project (i.e., *‘to develop a solution to aid the needs of the growing population of people with impairment and disability needs’*) and also shaped the structure of the user studies. In the interviews, the participants were asked to answer interview questions (initially) primarily concerned with functionality and usability aspects based on their impressions and interpretations of the AT in specific situations (i.e., to – from bed, bathroom, wheelchair etc.) and environments (home, hospital). They were also asked to describe their impression of the AT’s aesthetics, but in retrospect, questions on aesthetics and meaning were not addressed to the same extent as questions on functionality and usability. Although emotional perceptions or consequences of use were not part of the interviews, they were nevertheless described by participants in the primary user category to influence use and acceptance, and the information was followed up on when mentioned. Based on the findings from User Study 1, the SDQ was therefore included as part of the second user study - although not to elicit information on needs for acceptance and use, but to gather information on what the participants perceived the AT to communicate. Nevertheless, since questions on meaning and emotions were not specifically posed in the interviews, the participants might have gotten the impression that their thoughts on this topic were not relevant for the study, which can have influenced if and how they described these 'softer aspects' in relation to needs for acceptance and use.

Yet another aspect to consider is that the participants' responses to and descriptions of needs for the AT were primarily based on the information they received through the visual representation of the AT. These provided information on the appearance of the AT, its visual aesthetics, its expression, and how and where to use it. However, the amount of information on different aspects of the concept varied as the AT only existed in the visual PRs. This means that, for example, haptic information was not available for the participants to evaluate; a product's tactile properties and experience of physical comfort must be evaluated through physical interaction and use. Nevertheless, functionality, usability and safety/security-related needs were described in more detail by all user categories than their needs were for aesthetics and meaning that are associated with the communicative dimension of the product.

An explanation (in addition to the previous comment regarding the interviews) as to why the latter needs were described less, and with less detail, can be the notion of a hierarchy of needs as proposed by Jordan (2000). The needs for, for example, functionality, usability and accessibility must be met before other needs are fulfilled. Another explanation is that these needs were more difficult for participants to verbalize and communicate compared to needs for functionality, usability and accessibility. This suggestion is supported by prior research arguing that users' difficulties in verbalizing these needs can be connected to the lack of a language in addressing the communicative aspects of product design (Wikström 2002). This was also confirmed in the findings from the user studies, particularly in the second part of User Study 2 where a participant in the professional category described the difficulty in describing feelings in relation to AT and AT use - *"It isn't that easy to put it into words."* (Male user, Group D). Nevertheless, as shown in the user studies, as well as in prior research, e.g., by McDonagh-Philp and Lebbon (2000) and McDonagh et al., (2002), these 'softer needs' are as important to fulfil as the instrumental needs are for the primary users to feel comfortable with using products such as ATs.

Based on the idea of the iceberg phenomenon (e.g., Jekel, 2007), Karlsson (2013) has suggested that information on user needs (and subsequent requirements for the design solution) is accessible in layers. Some information belongs to a layer 'above the surface' and is, therefore, easier to capture, for example with interview questions. Other information is found at different layers 'below the surface' and is more difficult to elicit. This information concerns needs which are less conscious and therefore more difficult for users to describe and consequently to communicate. Needs related to aesthetics, product meaning, and emotional aspects can be argued to belong to this category. Nevertheless, the PRs in combination with the SDQ seemed to have worked as mediating tools (cf. Karlsson, 1996) in reaching these 'deeper' layers and for the participants to reflect and describe meaning and emotional aspect of the AT and consequences of AT use.

## 5.2 Addressing RQ2

Research question 2 was formulated as: *(RQ2) What in the design of the AT product gave rise to negative or positive perceptions and associations (and why)?*

### 5.2.1 The product as whole

The participants' understanding and interpretation of the AT design, what they perceived it to communicate and what meanings they ascribed to it can be attributed to different elements or parts of the design, both in relation to each other and as a whole (according to how Monö, 1997, defines 'the whole'). Technical and ergonomic features were consistently understood and judged not only based on their primary purposes but also on the basis of what they communicated.

While it is acknowledged that the participants did not perceive, comment, or judge different aspects of the AT in terms of functional features, technical components and form characteristics, it is useful from a design perspective to orient their perceptions and understanding of what they perceived the AT design to communicate to these

different elements of the product to understand what aspect of the design elicited reactions and why.

#### 5.2.1.1 Functional features

The majority of participants, regardless of category, thought the size of the device to be appropriate as it could provide accessibility in narrow spaces, although concerns were raised that its small size made it look unstable and thus was perceived as unsafe. The kneeing/stretching function to alter seat height to provide easy transfers to and from the device was thought to be practical, as uneven heights were an issue for many of the participants regardless of category. However, some of them described not feeling safe (participants in the primary user category) and/or not being instructed by their work supervisor (participants in the professional category) to carry out the transfer to and from the seat on their own.

Participants in the professional user categories thought the AT looked “*suitable*” for its purpose, “*easy to use*” and “*professional*” (models A and B). This view was specifically described in relation to how the different components and the “*many*” functional details made them feel “*equipped*” and “*efficient.*” Further, they perceived the optional astride seat position (in model A) and the gap in seat to be practical and to signify accessibility, efficiency, and ergonomic qualities, which together with other features, such as the adjustment of seat height and the pushing/steering rod with handlebars, made them feel “*equipped*” and “*professional.*” For participants in the primary user category, the same astride seat position, combined with the gap in the seat, communicated not only accessibility and usability but also vulnerability as they felt that this design solution meant that they were physically and emotionally exposed. Additionally, they perceived it to emphasize dependency and limited ability by revealing and marking out functions intended to support functional needs. Two of the participants from the primary user category thought the astride seat position looked “*strange*” and “*weird*” and one of the participants associated its look and the meaning this gave rise to with “*a forklift feeling.*”

To reduce negative feelings, and to better match the users' needs, the conceptual AT solution (model A) was modified. This resulted in the astride seat function being discarded, while the other functions were kept, such as the kneeling function to adjust seat height and the gap in seat to offer accessibility functions but for which an optional lid was provided (in model B). However, the participants' evaluation and reactions to the modified design showed similarities to how they perceived the initial AT design (i.e., model A). The function to adjust seat height was perceived beneficial by the majority, regardless of category, and participants in the primary use category judged the lid to be functional for the purpose of hiding the gap, although a few still felt the gap would be exposing.

#### 5.2.1.2 *Technical components*

The rechargeable, motorized wheels were thought to be efficient by the participants for whom accessibility and usability implied managing obstacles; the wheels provided ease of use. These users were participants with a caregiving role who described difficulties pushing and steering heavy AT aids, as well as participants in the primary user category who described getting physically exhausted by undertaking multiple transfers each day. The problems they described mirror needs which could potentially be met by the power-driven wheels. However, safety concerns were raised by participants in all categories who described feeling hesitant to use this motorized feature due to fear of it malfunctioning and of using it incorrectly, which could result in accidents and injuries. Nevertheless, some participants in the primary user category and in the professional home caregiver category judged this feature to be both useful for the purpose of providing accessibility while requiring less strength; it looked “cool”, and they felt “empowered.”

The handheld controller, which was added as an optional accessibility function to the altered AT concept (model B), was responded to in a similar way by participants in the professional care giving category. They were concerned about using it incorrectly due

to lack of experience of using such technology, which could result in accidents and injuries. Participants in the primary user category mainly judged it to be beneficial to meet their needs for accessibility and independence. Some concerns were raised regarding difficulty to operate and adjust speed in narrow spaces, but for the majority, this technology and its design were described to be familiar and easy to use. In addition, for one of them, this technical feature was perceived as a trait conveying a certain identity – *“It’s manly, like me”*. Another example of a technical component feature that was understood and judged not only based on its primary functional purpose was the tilt restrain function. This was added at the request of participants in the professional caregiver category to meet specific safety requirements. This feature was judged as *“rational”* and efficient by participants in the professional user category, but for participants in the primary user category, this same safety feature was interpreted as diminishing and interfering with desired identity.

#### 5.2.1.3 Form characteristics

While participants in all user categories thought the AT’s overall appearance looked *“nice”* and *“neat”*, participants in the primary category also found its style and silhouette to look *“modern”* and *“slightly futuristic.”* One of them thought the shape of the seat with the backrest resembled a design chair with a *“soft and clean”* form, which was positively perceived as it would be – *“... much easier to live with”* in comparison to other ATs whose appearance several of the participants described as *“... screams aid.”* However, another participant thought its appearance to look *“just like an up-dated shower chair”* (model A).

When the participants answered the SDQ some of what they had described the AT to look like in the interviews were confirmed. For example, regardless of user category they thought the AT looked *“practical”* but nevertheless *“non-functional.”* Thus, even if the AT gestalt communicated ease of use and functionality, it was judged to be non-functional. The explanation was that there were other aids used for the same or similar purpose and therefore they did not see a need for the conceptual AT. In addition,

despite the participants in the primary user category emphasizing some of the functional features of the conceptual design to be physically and emotionally exposing in the interviews, the majority of them marked adjectives in the SDQ describing the AT as “*appealing*”, “*pleasant*” and “*dignified*.” This indicates that there were contradictions in how they interpreted the meaning the AT was perceived to communicate. These contradictions could be a consequence of the differences between the interviews, which focused more on details, and the SDQ where the participants were asked to consider the product gestalt as a whole.

#### 5.2.1.4 Arrangement of parts and components

The findings further indicate that how the AT design was understood and the meaning the participants perceived it to communicate, were influenced by how individual parts of the AT design were organized in relation to and in combination with other parts and components of the design, such as the sitting position in combination with the gap in the seat influenced. This observation corresponds to how Monö explains parts in themselves to be gestalts, which when arranged together can form a ‘new’ whole and function as a gestalt of its own (Monö, 1997, p. 33). He also explains how a gestalt is influenced by the way its elements (i.e., material, colour, form, structure, etc.) work together, thus they are not isolated factors in the whole. Yet, a change to an individual element affects how the whole is understood (ibid). For example, how the seat was positioned in relation to the wheels, indicating the possibility for a person to sit, in combination with the handlebars communicated that the product was intended to be moved and pushed. The seat position facing the pushing handlebar communicated the possibility for eye contact. Similarly, the outward angle of the legs in combination and connected to the seat can be considered to have communicated "stability." However, at the same time, the findings showed that some of these combinations, such as the astride seat in combination with the gap in the seat, for participants in the primary user category came with a meaning of exposure and limited ability, while most of the professional caregiver category the same design elements communicated rationality, professionalism, and capability. Moreover, the powered wheels in combination with

the hand control and the seat were perceived as an unsafe combination because safety could be compromised. This shows how the parts individually and together as a whole were interpreted to communicate different things (in addition to individual experience, interest, preference, etc.) depending on the message recipient's role, situation, and use context.

#### 5.2.1.5 *The influence of the use environment*

In addition, how the participants understood the different parts in relation to each other and as a whole, what they perceived the AT design to communicate and what meanings they ascribed to it can be understood to have been influenced not only by their different roles, situations and/or individual characteristics but also by the environment of use and other artefacts within (cf. Monö 1997). For example, hospital environments are often more spacious compared to home environments, and while private homes and the artefacts within are considered to reflect an individual's identity, style and values (see e.g., Goffman 1959; Pullin 2009), hospital environments and the artefacts within may be expected to be neutral, impersonal and to reflect clinical cleanliness. These are factors that can influence how people perceive a product, what meanings they attribute to it, and thus also influence their reactions to a proposed design.

Findings from the user study interviews show that the participants in the primary user and the home caregiver categories judged if and how the AT would fit in home environments. For example, its size was evaluated in relation to "*narrow*" bedrooms and "*cramped*" bathrooms, as were the power wheels and the ability to manoeuvre the device. Participants in the primary user category assessed its appearance and aesthetics in relation to whether it could "*melt*" into the surroundings, be "*stylish*" and "*fit nicely*" into a home interior. One of them specifically described how he would not feel more "*handicapped*" having it standing in his home. Furthermore, to make the AT more personal and representable to reflect their individual style and home, decorative details were requested. However, findings from the SDQ show that most of the

participants thought the AT fitted equally well into the different environments shown, indicating that the environments did not impact on how they perceived its design in terms of the aspects that were rated. It is possible that the photos of different environments that were shown can have been too similar in character, which can have affected how the participants perceived the AT to fit in.

### 5.2.2 The product as a symbol

The findings show that the participants judged not only what the AT communicated about itself, and its properties, but also what the AT was perceived to communicate about the participants themselves (i.e., the users), such as being “*manly*”, “*professional*”, and “*capable*.” This was specifically shown in how participants in the primary user category reacted to the hand control as a sign of a certain identity and reacted to the tilt restrain function preventing the AT from overturning to also reflect the character of the user as being a cowardly “*chicken*” (model B). This finding resembles Monö’s explanation of how an artefact can be used as a (semiotics) sign to represent and communicate a person’s sense of value, group belonging etc., and how this aspect and related needs can sometimes be “*more important than technical and practical functions*.” (Monö 1997, p. 11). Thus, “*design can signify something other than its original purely use function*.” (ibid.) Crilly et al., (2004) proposed a similar explanation to how a semantic expression that defines a product’s character (such as utility properties) can also be interpreted as symbolic values and thus reflect the character of its users. Crilly et al., (ibid., p. 18) further explained that “*...there is not necessarily a clear distinction between the symbolic value associated with a product and semantic interpretation of its instrumental (or utilitarian) value*.” However, the symbolic values the participants in the four user categories perceived the AT’s features to symbolise differed depending on their respective roles, experiences and contexts of use. For example, while participants in the primary user category described features intended to enhance accessibility as symbolising dependency, the same features were perceived as efficient for participants in the professional caregiver categories, they made them “*feel equipped*” and symbolised “*professionalism*.”

Moreover, both Monö's (1997) annotation of how things can become signs of identity and Crilly et al.'s (2004) explanation of how the symbolic value of a product can be interpreted to reflect a user's character are connected to how Dittmar (1992) conceptualizes objects as '*symbolic mediators of identity*' used as symbol-bearing objects to communicate and clarify a person's identity, social position, and personal qualities to her-/himself as well as to others. That is, the participants perceived the AT to express personal traits such as identity, to '*differentiate*' the person from others (Dittmar in Crilly et al., 2004, p. 16) and to signify work professionalism which can be understood both as an *instrumental* aspect with a user-related meaning, symbolizing capability in control etc., as well as a *symbolic categorical* aspect allowing persons to express group membership (i.e., profession) and thus '*integrate*' the person with others (ibid., p. 16). However, the understanding is that Dittmar's model primarily describes the symbolic meaning of products based on the fact that they are specifically selected to symbolize a preferred image, style, and identity that the user or owner wants to identify with and wants others to see them as. This was not the situation in the user studies where participants were asked to reflect and describe their needs for a specific, pre-selected product design. The situation can be compared to the situation of the participants in the primary user category in relation to other AT products they use or are offered. These products are often selected by rehabilitation specialists (cf. e.g., Wessels et al., 2003; de Witte et al., 2018; Nordic Centre for Rehabilitation Technology (NUH), 2007). Yet, several of them as well as the participants in the professional use categories described their reflections on specific features of the AT as well as the AT concept as a whole as an object with abilities to enhance their identity, character and show group belonging, etc.

The symbolic meaning that participants attributed to the AT, such as feeling capable and professional, can also be compared to how Lai (1995) describes how customers value products based on what benefits could be derived from consumption, possession, or use, such as '*aesthetic benefits*' in terms of enhancing personal expression and '*social benefits*' conveying group belonging. This was shown in both user studies

where participants (primarily in the primary category) described how the design was perceived to describe their personal expression in terms of identity and capability. Their experience in deriving benefits beyond the instrumental aspects of AT use can also be linked to how Jordan (2000) describes '*socio-pleasure*' in terms of how a product can facilitate social interaction and '*ideo-pleasure*' referring to the "aesthetics of a product and the values that a product embodies" (ibid., p. 265). This was shown when participants (in the primary user category) thought the AT design characteristics to resemble a design chair and which was positively perceived as it, for example, symbolized "*the right thing*" such as a "*cool*".

### 5.3 Addressing RQ3

Based on earlier research (see Introduction, section 1.1.), as well as the user studies presented here, it is evident that the design of ATs comes with several challenges. Therefore, the design project and its design process were used as a case to address the third research question, (RQ3): *What are the implications for design?* The summary of the findings is presented without any internequine hierarchical order.

#### 5.3.1 Fulfilling users' conflicting and contradictory needs

One challenging issue has to do with the gestalt of the AT and the use context. Users perceive and interpret design features and characteristics differently. Users in one category may want the AT to have a unique style, suitable for their personal use context, while another category who uses the same AT solution in their work context can feel professionally equipped by having a device with an appearance expressing instrumental, 'work-oriented' functions. These are aspects that impact their expectations for the design of the AT, the needs that should be met and how they should be met. Therefore, an AT product can be accepted by users in one user category and be rejected by users in another category. Consequently, features and characteristics in the AT design that users perceive as acceptable vary. In some cases, there could even be conflicts between users from within the same user category (i.e., the primary users wanted both a neutral AT to blend into the environment and a cool

AT that stood out in the environment) and between the different user categories (e.g., rational vs diminishing). Additionally, users can describe similar needs but the meaning they ascribe or associate to the need can differ. From a design perspective, it is difficult to fulfil different users' different needs for an AT that is to be positively perceived and used by different users in their respective roles, use situations and environments. This can result in an AT having a too 'neutral' or standardized 'one-size fits all' appearance focused on fulfilling 'only' functional needs. This can mean a risk that the category of users for whom the aid is primarily aimed feels marked by the AT. This could not only make product interaction and use unpleasant but could also lead to the AT not being used as intended, resulting in (if possible) rejection or abandonment.

### 5.3.2 Understanding, interpreting, and implementing users' needs

An additional design challenge has to do with needs not being described in detail. For example, participants in the primary user category wanted the AT to be aesthetically pleasing, to express dignity and wanted decorative add-on details to personalize it as they wanted to feel proud of it. However, what specific expressions, aesthetics, and decorative details they wanted the AT to have, were not described in any detail, which could make it difficult to fulfil these needs.

Furthermore, although the AT was modified after the participants' feedback in User Study 1, with the aim of matching their needs and increasing the possibility for acceptance, the resulting design solutions were perceived by some of the participants in the primary user category as exposing, with demeaning features (gap in seat), and to communicate dependency or functional limitation (restrain tilt wheels). This can be the result of their needs not being fully understood by the designer and/or an inability by the designer to interpret and transfer their needs into design parameters to be implemented in the design, and/or that conflicting needs were described which made the design task to match their need complicated.

Another aspect influencing whether and how the users' needs were understood and implemented has to do with the choice of method for collecting information. The indication is that the functional aspects of the users' needs for AT were described in more detail compared to the 'soft' aspects of AT and AT use. In addition, the product representations (i.e., the images) that supported the interview showed 'only' one design proposal (at a time), which can be understood to have limited the participants' ability to describe or reflect on aesthetics and other 'soft' aspects as there were no alternatives to relate to. These are factors that, together with the participants' difficulty to verbalize all aspects of needs and consequences of use, can be understood to have indirectly influenced the design solution. Furthermore, even if the participants' needs were interpreted correctly and implemented in the design, 'negative' meanings associated with AT products in general can have influenced how they perceived the AT concept and what it was understood to communicate about themselves and to others. For example, in User Study 2 one participant described how patients after surgery sometimes refused to use an AT, even if only temporarily, because of the negative emotions it evoked. This illustrates that it is not only the design of an AT per se that impacts user acceptance but also what meaning it is associated with, as well as for whom these 'niche-products' (cf. Plos et al. 2012) are developed and whether potential users can identify themselves with this intended user.

### 5.3.3 Communicating a message

From Monö's design perspective, a product gestalt communicates a message. This message can be intended or unintended. Therefore, if an AT is intended to communicate something beyond its obvious technical and practical facts, and counteract that it is misunderstood (e.g., resulting in it not being used or not used as intended or to the fullest potential), it is important that the designer knows what message is to be transmitted through the product design. Additionally, the design must ensure that the message is effectively transmitted through the product gestalt, i.e., not interrupted by flaws in its construction, manufacture, product finish etc. (Monö, 1997). This means that a design that encompasses various parts and

components, and which uses these part and components, as well as their arrangement and the relationships between them (cf. section 5.2.2.4.) to *describe*, *express* and *exhort* users' reactions or behaviour, and *inform* the user about the product's purpose and how it is intended to be used, must each individually and jointly be considered in relation to whether and how they contribute to communicate the intended design message. In the specific design project, the intention was to communicate a multifunctional, user-friendly, lightweight, contemporary and attractive AT device that was to be used in different environments by different users to support and enhance safe individual transfers and provide independence. The findings show that participants thought that the AT looked easy to use and flexible and, further, that its purpose was understood, which can be interpreted as though the design communicated the intended message. However, the findings also show that some of the sought characteristics, such as safety, were not interpreted as intended. Some participants perceived the AT as unsafe to use (unstable, easy to tip over, power wheels) and difficult to operate with precision, which they thought could result in accidents.

Yet another aspect to consider when designing an AT product is that its meaning (including the arrangement of its parts and components, their relation to each other and together as a whole) will be influenced by different users' different situations and use contexts, which can affect and change the intended meaning of the product. This can in turn result in the product not being considered adequate for fulfilling the users' needs and expectations in a specific situation (cf. Monö, 1997, p. 136.). Thus, adding to the challenges of designing an AT gestalt that can be accepted and used in different situations and environments and by users with different roles in using an AT, is that other artefacts in the surroundings of the AT will affect how it is interpreted.

#### 5.3.4 Choosing the design strategy

An additional aspect of designing AT for acceptance and adoption has to do with the designers' own views (influenced by individual qualities or characters, e.g.,

temperament, knowledge, experience, preferences and attitudes shaped by socially constructed norms) of AT and what an AT product is to communicate through its gestalt, as well as whether and how their intention with the design matches users' expectations and needs.

Newell (2003, p. 4) described AT designs as having an " ... *institutional 'air' about it - being' more suited to a hospital ward than a living room.*" Hocking (1999) argues that AT products are not designed for the person but for disability. Participants in the primary user category experienced ATs to be designed with a functional-oriented perspective at the expense of, for example, aesthetics. However, the 'absence' of aesthetic decorative details together with only focusing on functional purposes of a product can be described as an aesthetic in itself that designers of AT can perceive as the look and style that these products are expected to communicate. This argument is partly supported by participants in the primary user category who described ATs to be "*undesigned*", and "*engineered looking*", suggesting that they perceived the functional-oriented aesthetic style as lacking aesthetic qualities.

The idea guiding the design of the conceptual AT, i.e., 'to develop an aesthetic, multifunctional, and user-friendly' can be described to have followed a form-follows-function design strategy that can be compared to Monö's perspective of product design, where he argues that "*Design should convince, not seduce*" (Monö, 1997) by "*describing its purpose, method of operation and construction very clearly.*" He describes decorative features on products to be "false" from a semantic point of view (Monö, 1997 in Hjelm 2002, p. 17), and therefore to be disqualified. From this perspective, the form-follows-function strategy can partly be argued as having failed to match the needs and expectations of participants in the primary user category for the AT, desiring a cool, extraordinary aid and decorative details to make the AT representable, to match their individual style and preferences and thus make it more comfortable to use. On the other hand, adding decorative details is a way to express individuality,

meaning that regardless of 'if' the AT was perceived to be aesthetic or not (taste being subjective), the need to add personal style can remain.

However, the form-follows-function strategy emphasizing the product's purpose and functions can, on the other hand, have benefited the participants' understanding of product origin and its purpose and how it was to be handled (cf. Monö, 1997). Whether the design strategy can be considered justified or the 'right' choice for the purpose must be viewed in relation to what functions the AT could fulfil for the participants in their different roles and use situations. For example, participants in the healthcare professional user categories, for which the AT could reduce work injuries and accidents, be efficient and easy to use, the design strategy form-follows-function can be considered appropriate. For participants in the primary user category, who use ATs to support or provide mobility and independence and not only expected the 'new' AT to be functional but also to be aesthetic and to match and fit personal style etc., the form-follows-function strategy might not have been quite as expedient. However, which specific design strategy that should have guided the design of the AT to better match all four different user categories' needs and expectations for an AT is not evident. This is an issue that is important to investigate further to prevent that ATs are designed in ways that do not meet users' needs and expectations and therefore not accepted and used.

## 6 General discussion and conclusions

### 6.1 Reflections on the theoretical framework

To investigate how to design for acceptance and adoption, a conceptual design project including two user studies generating empirical data was analysed and reflected on to identify and compare how users in different user categories perceived and understood an AT and what needs and aspects of use they described – beyond functionality and usability – to be important to be met for AT acceptance and use.

The theories and models described in the framework clearly acknowledge that user-centred design of products cannot consider only instrumental user needs but also softer aspects. According to the findings, this applies also to the design of AT.

The benefits proposed by Lai (1995) and the product pleasures proposed by Jordan (2000) offered a list of aspects to consider, the importance of which (some, but not all) were confirmed in the user studies, for example the relevance of considering the aesthetic, affective, social, and situational benefits proposed by Lai, as well as the psycho-, social-, and ideo-pleasure proposed by Jordan.

Monö's (1997) notion of the product as a trinity served to orient users' needs (and consequent requirements for the design) towards different aspects of a product (i.e., the ergonomic, technical and communicative dimension) which can be useful to identify basic needs, including *functionality*, *usability*, *ergonomic needs*, and *needs for certain meanings*, as well as to evaluate design concepts.

More importantly though, Monö's product semantic framework and the notion that product design is a 'language' that conveys a message through its gestalt was essential when analysing how the participants perceived and understood the AT and why. This communication perspective of the product as a transmitter provided a broader perspective on user needs for AT as well as a tool to more in-depth understand how

the participants' perceived and interpreted the product design and the meaning it communicated. Monö (ibid.) argues that individual qualities, social and cultural values, and context of use influence users' attitudes, perception and understanding of products, and what meaning a product is attributed or considered to convey to the user as the recipient of the message transmitted by the product design. However, he does not explain how to understand a user's (as the receiver of the messages conveyed) reaction to the product depending on these individual differences or use contexts that influence the user's interpretation of the product and the attribution of meaning.

Dittmar's (1992) symbolic-communicational model complements Monö's framework by schematizing and dividing the relationship between identity and object-related meanings for how products are used as symbol-bearing objects to communicate or enhance identity to the product user him-/herself and to others. On the other hand, Dittmar's model does not provide an explanation for how to understand which features in the product affect the instrumental or symbolic identity values the users perceive the product to symbolize.

In summary, the frame of reference, describing different theories and models, partly overlapping and partly complementing each other, was useful for the analysis and understanding of the collected data. Although the main focus was Monö's product semantic framework, other complementary theories and models were essential to cover the different aspects more in depth. However, one aspect identified as important to the participants in the user studies was the emotional aspects related to AT acceptance and use. The references included in the frame of reference mention (e.g. Lai's affective benefits) but do not specifically describe or elaborate on emotions and emotional reactions related to product use. Therefore, in future user studies aimed at investigating and understanding how to design for acceptance, it is recommended that additional theories and frameworks describing emotions related to product use are included, for example, the product emotion framework proposed by Desmet (2002).

## 6.2 Reflection on the choice of methodology

The choice of data collection methods, participants, the role of the person gathering the information and analysing it, and the purpose behind, are all factors that influence what type of information is collected, and how it is understood. The researcher's (in this case own) experience of using AT aids and design experience of AT design no doubt impacted the interpretation of the data collected, how it was analysed and what topics were penetrated. However, these experiences and preunderstanding of the topic can also have supported the researcher's ability to understand the data more in-depth and draw conclusions, as well as to suggest possible explanations for the implications. This is also in line with the criteria for qualitative research, where "*the researcher is seen as the instrument of research*" (Maxwell, 2013, p. 91).

Furthermore, in research through design (RtD) (e.g., Forlizzi et al., 2009; Zimmerman et al., 2007) researchers' pre-understanding and subjectivity are considered as enabling their understanding of, and conclusions drawn from, the data. The researcher's preunderstanding and design profession, as well as being a wheelchair user, can have supported the interviews with the participants in terms of building trust and credibility between the interviewer and the participants. In particular it may have benefited the depth of their reflections and answers, as the participants defined as primary users could identify themselves with the person conducting the interview (i.e., being AT users). From this same perspective, the participants in the professional user category can have emphasized their 'professional' role in the interview situation to contrast their role in regard to the interviewer. Thus, these factors can have impacted the type of information that was gathered. Nevertheless, the researcher's subjectivity and experience of using different ATs were part of the driving force for the ideation of the design project, and the basis for the research approach. Without the pre-understanding and subjectivity, the research study would not have been conducted and most probably important user information would not have been made accessible.

The researcher's process developed and was guided by a disruptive and intuitive design process (cf. Prochner and Godin, 2022). Therefore, the process of seeking answers to the research questions under investigation was guided by a pragmatic 'what will work best' approach. That is, the iterative design process of an AT solution in a design project (encompassing the two user studies with four categories of users evaluating and verifying the design concept to ensure that user requirements were met) influenced not only the outcome of the design but also how the research process was conducted. That is, information and knowledge gained from the first user study affected not only how the AT solution was developed/modified, but it also impacted the research process in terms of the decision to develop and include a complementary data collection method to the interviews in the second user study, i.e., the semantic differential questionnaire (SDQ).

Furthermore, even if sufficient information has been provided on how the research process was conducted so that it could be possible for another researcher to reproduce the study, it is not likely that another researcher will reach the same conclusions as those presented here. Their experiences, roles, knowledge etc., will influence the analysis and the conclusions drawn from the findings. Additionally, the transferability of the research outcome can be described as being dependent on the context in which the research was carried out, such as the participants' specific roles, situations, and environments for using AT. From a positivistic perspective, the research process is not replicable (cf. Prochner and Godin, 2022), however, its resulting design process could be replicable. That is, the knowledge generated from the process is applicable and transferable to another research context to inform other studies, for example investigating users' needs for a product in another research context.

Further, as described previously, the design project's problem-solving perspective impacted the structure of the research process. Instead of focusing on investigating users' needs as the basis for proposing a design solution (which is the conventional practice of initial user studies) the participants in the first user study evaluated and

responded to a pre-defined design solution. This can question the credibility and quality of the findings of the user studies in terms of how well they reflect users' 'real' needs. The reason for not following the 'traditional' user-centred design process was that the design project had to comply with the requirements of the open-call process. However, the concept was evaluated and assessed by a team of experts, stakeholders and manufacturers before it was presented to the participants in the user studies. In addition, compared to an interview situation where participants 'only' answer questions on AT needs, the product representations (PRs) of the pre-defined design, together with the SDQ, functioned as 'mediating tools' (cf. e.g., Karlsson 1996), which can be understood to have prompted the participants to reflect and respond to the solution and its proposed functionality in a more open and explorative manner than merely answering questions on needs without the support of PRs. Thus, by using the PRs of the pre-defined solution, different types of needs could be identified, including those described as 'soft' – which were difficult for the participants to describe but were nevertheless identified as important for AT acceptance.

To sum up, the quality indicators of the research can be described to be grounded in a combination of a constructivism paradigm, in terms of seeing realities as being constructed through context and experience, and on pragmatism, where multiple realities are perceived based on a transformational ontology grounded on the view that reality can be changed for the better (Prochner and Godin, 2022).

### 6.3 Conclusions and contributions

The demand for assistive technologies (ATs) that can support and improve independence and reduce disability is globally growing. More and more people use AT and more people will need ATs to accommodate different needs. However, despite the positive benefits of ATs developed to meet different needs, ATs can be abandoned or rejected by the people in need of them as the AT may not fulfil their needs and/or expectations. While there is a rich body of knowledge, produced by healthcare professions such as occupational therapy and physiotherapy, describing users' needs

for AT and factors related to user acceptance and rejection of ATs, there is a knowledge gap of detailed information of relevance for design and design decisions. Furthermore, there is little research comparing different categories of users' needs and experiences of and with ATs that they commonly use and how (or if) their needs and experiences are related to AT acceptance or rejection. This is information that can support designers to design for AT acceptance and use. As a step towards filling this knowledge gap, participants belonging to four different user categories' needs, product experiences and preconditions for acceptance and use of an individual mobility AT transfer device have been compared and analysed, reflected on and conclusions drawn from a design perspective.

The findings show that detailed information on needs that are important to fulfil for acceptance and use appears to be accessible in layers. In the studies, detailed information on instrumental, 'tangible' needs (e.g. for usability and accessibility) was easier to elicit than less tangible or 'soft' needs such as needs for aesthetics, meaning and emotional needs. At the same time, these 'soft' needs were emphasized as very important to be met for acceptance to be possible by participants, in particular those in the primary user category. To elicit a more complete picture of users' needs for AT, the results suggest that product representations (PRs) in combination with a Semantic Differential Questionnaire (SDQ) can be useful as mediating tools to support users to reflect on and describe different types of needs, in particular, what is here described as 'softer' needs for ATs. Furthermore, the research contributes with novel information showing that users in different user categories can describe the same needs for AT, for example, functionality, usability, accessibility, and safety, but that the meanings they attribute to these needs and how they are expected to be fulfilled may differ. The meaning or interpretation of, for example, the need for safety/security, differed depending on the users' respective roles, situations, contexts, and in which environment the AT would be used.

Moreover, the participants' understanding and interpretation of the AT design, what they perceived it to communicate and what meanings they ascribed to it were attributed to different elements or parts of the design, both in relation to each other and as a whole. Technical and ergonomic features were consistently understood and judged not only based on their primary purposes but also on the basis of what they communicated. Furthermore, the same design was also interpreted by participants to communicate and symbolize, for example, their identity. Hence, the same parts and elements of a design that describe and convey a product's primary functions, for example, functionality, accessibility or usability, also communicate intangible qualities. The interpretations of what the product communicates through its gestalt differ depending on user category and their different roles, situations, contexts, etc. For example, a design element that is interpreted as communicating 'efficiency' by one category of users can be interpreted as communicating 'vulnerability' by another, as shown in the user studies. In the specific case, this may signify the acceptance by one user category and the rejection by another.

The findings imply that users' acceptance of AT is not merely an outcome of the assessment of objective features like functionality, ergonomics, or safety. It is a more complex process impacted by subjective perceptions of the meaning users derive from the product. In other words, the semiotic elements, or communicative aspects of AT cannot be decoupled from its more overt functional attributes when considering user acceptance. These multi-layered interpretations and meanings offer valuable insights into factors that significantly impact user expectations for ATs and willingness to accept different design solutions in the field of AT.

## 7 References

Agree, E.M. (2014). "The potential for technology to enhance independence for those aging with a disability." *Disability and Health Journal*, 7(1), S33-S39.

Astell, A. J., McGrath, C. & Dove, E. (2020). "That's for old so and so's!": does identity influence older adults' technology adoption decisions? *Ageing & Society*, 40 (7), 1550-1576. ISSN 0144-686X

Bichard, J-A., Langdon, P. & Coleman, R. (2007). 'Does My Stigma Look Big in This? Considering the Acceptability and Desirability in the Inclusive Design of Technology Products'. In *Universal Access in Human Computer Interaction. Coping with Diversity: 4th International Conference on Universal Access in Human-Computer Interaction, UAHCI 2007, Held as Part of HCI International 2007, Beijing, China, July 22-27, 2007, Proceedings, Part I*, 4, 622-631. Springer Berlin Heidelberg

Bright, A. K. & Coventry, L. (2013). "Assistive technology for older adults: psychological and socioemotional design requirements." In *Proceedings of the 6th International Conference on Pervasive Technologies Related to Assistive Environments* (p. 9). ACM.

Brinkmann, S. (2014). Unstructured and Semi-Structured Interviewing. In P. Leavy (Ed.), *The Oxford handbook of qualitative research* (pp. 277-299). New York: Oxford University Press.

Chester, M., Hocking, C., & Smythe, L. (2020). Providing, receiving and using equipment: A hermeneutic literature review. *New Zealand Journal of Occupational Therapy*, 67(2), 6-13.

Crilly, N., Moultrie, J. & Clarkson, P.J. (2004). Seeing things: consumer response to the visual domain in product design. *Design Studies*, 25, 547-577.

Czarnuch, S., & Mihailidis, A. (2011). The design of intelligent in-home assistive technologies: Assessing the needs of older adults with dementia and their caregivers. *Gerontechnology*, 10(3), 169-182. <https://doi.org/10.4017/gt.2011.10.3.005.00>

Desmet, P. & Hekkert, P. (2007). Framework of Product Experience. *International Journal of Design*, 1, 57-66.

Desmet, P. M. A. (2002). Designing emotions (Doctoral dissertation). *Technical University of Delft, Industrial Design Engineering, Delft.*

Dittmar, H. (1992). *The social psychology of material possessions: To have is to be.* Palgrave MacMillan.

Forlizzi, J., Zimmerman, J. & Stolterman, E. (2009). From design research to theory: Evidence of a maturing field.

Freedman, V., Kasper, J. and Spillman, B. (2017). Successful aging through successful accommodation with assistive devices. *Journals of Gerontology: Social Sciences.* 72, 300–309. <https://doi.org/10.1093/geronb/gbw102>

Federici, S. & Borsci, S. (2016). Providing assistive technology in Italy: The perceived delivery process quality as affecting abandonment. *Disability and Rehabilitation: Assistive Technology,* 11(1), 22-31. <https://doi.org/10.3109/17483107.2014.930191>

Glaser B.G. & Strauss A. L. (1968). *The discovery of grounded theory: Strategies for qualitative research.* London: Weidenfield and Nicholson

Goffman, E. (1959). *The Presentation of Self in Everyday Life.* Garden City, NY: Doubleday.

Goffman, E. (2002). *The presentation of self in everyday life.* Garden City, NY, 259.

Ilstedt Hjelm, S. (2002). *Semiotics in product design.* Report number: CID-175. ISSN number: ISSN, 1403-0721.

Hocking, C. (1999). Function or feelings: Factors in abandonment of assistive devices. *Technology and Disability,* 11(1), 3-11.

Hoening, H., Taylor, D.H. & Sloan, F. A. (2003). Does assistive technology substitute for personal assistance among the disabled elderly? *American Journal of Public Health,* 93, 330-337.

Holloway, C. & Dawes, H. (2016). Disrupting the world of Disability: The Next Generation of Assistive Technologies and Rehabilitation Practices. *Healthcare technology letters,* 3(4), 254–256. <https://doi.org/10.1049/htl.2016.0087>

International Organization for Standardization. (ISO). Assistive products - Classification and terminology (ISO 9999:2022)

Jekel, J. F. (2007). Epidemiology, biostatistics, and preventive medicine. Saunders/Elsevier, UK.

Jordan, P. W. (2000). Designing pleasurable products: an introduction to the new human factors.

Karlsson, I. C. M. (1996). User requirements elicitation. A framework for the study of the relation between user and artefact. Dissertation. Gothenburg: Chalmers University of Technology

Kintsch, A. and De Paula, R. (2002). A framework for the adoption of assistive technology. SWAAAC 2002: Supporting Learning Through Assistive Technology, 3, 1-10

Kvale, S. and Brinkmann, S. (2015). Interviews: Learning the Craft of Qualitative Research Interviewing. 3rd Edition, Sage Publications, Thousand Oaks, CA.

Shinohara, K., and Wobbrock, J. O. (2011). In the shadow of misperception: assistive technology use and social interactions. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 705-714).

Lansley P., McCreadie C. and Tinker A. (2004). Can adapting the homes of older people and providing assistive technology pay its way? Age and Ageing, Volume 33, Issue 6, November 2004, Pages 571-576, <https://doi.org/10.1093/ageing/afh190>

Lai, A. W. (1995). Consumer values, product benefits and customer value: a consumption behavior approach. ACR North American Advances.

Mallin, S.S.V., and H.G. de Carvalho., (2015). Assistive technology and user-centered design: emotion as element for innovation. Procedia Manufacturing, 3, 5570-5578. <https://doi.org/10.1016/j.promfg.2015.07.738>

Maslow, A. H., (1987). Motivation and Personality 3rd Edition, Harper and Row, New York, NY

Maxwell Joseph A. (2013). *Qualitative research design: An interactive approach* (3rd edition). Thousand Oaks, CA: SAGE Publications.

McCarty, C. (1992) Design for independent living. *Super Interesting Magazine*. November, 1992, pp.66-70.

Miles, M. B., and Huberman, A. M. (1994). *Qualitative data analysis: An expanded source book* (2nd ed.). Thousand Oaks, CA: Sage.

Mortenson, W.B., Pysklywec, A., Fuhrer, M. J., Jutai, J.W. Plante, M., and Demers, L. (2018) Caregivers' experiences with the selection and use of assistive technology, *Disability and Rehabilitation: Assistive Technology*, 13:6, 562-567, DOI: 10.1080/17483107.2017.1353652

Monö, R. (1997). *Design for product understanding: the aesthetics of design from a semiotic approach* translated by M Knight, Liber, Stockholm, Sweden

McDonagh-Philp, D. and Lebbon, C., (2000). 'The Emotional Domain in Product Design'. In *The Design Journal* 3(1): 31-43

McDonagh, D., Bruseberg, A., and Haslam, C. (2002). *Visual Product Evaluation: Exploring Users' Emotional Relationships with Products*. *Applied ergonomics*. 33. 231-40. 10.1016/S0003-6870(02)00008-X.

Naess, I. and Ortsland, T. (2005). *Inclusive Mainstream Products*. In: Conference proceedings INCLUDE 2005, Royal College of Art, Helen Hamlyn Research Centre, London

Newell A. (2003). *Inclusive design or assistive technology*. In: Clarkson J., Keates S., Coleman R., Lebbon C. (eds) *Inclusive Design*. Springer, London. [https://doi.org/10.1007/978-1-4471-0001-0\\_11](https://doi.org/10.1007/978-1-4471-0001-0_11)

Nordic Centre for Rehabilitation Technology [NUH]. (2007). *Provision of assistive technology in the Nordic Countries* (second ed.). Vällingby: Nordic Cooperation on Disability.

Norman, D. A. (2004). *Emotional design: Why we love (or hate) everyday things*. Civitas Books.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). The measurement of meaning (No. 47). University of Illinois press.

Pape, T. L. B., Kim, J., & Weiner, B. (2002). The shaping of individual meanings assigned to assistive technology: a review of personal factors. *Disability and rehabilitation*, 24(1-3), 5-20.

Parette, P., & Scherer, M. (2004). Assistive technology use and stigma. *Education and training in developmental disabilities*, 217-226.

Phillips, B. and Zhao, H. (1993). Predictors of assistive technology abandonment. *Assistive technology: the official journal of RESNA*. 5 (1), 36-45. doi: 10.1080/10400435.1993.10132205. PMID: 10171664.

Plos, O., Buisine, S., Aoussat, A., Mantelet, F., & Dumas, C. (2012). A Universalist strategy for the design of Assistive Technology. *International Journal of Industrial Ergonomics*, 42(6), 533-541.

Prochner, Isabel & Godin, Danny. (2022). Quality in research through design projects: Recommendations for evaluation and enhancement. *Design Studies*. 78. 10.1016

Pullin, G. (2009). *Design meets disability*. Cambridge, MA: MIT Press.

Riemer-Reiss, M. L. & Wacker, R. R. (2000). Factors Associated with Assistive Technology Discontinuance Among Individuals with Disabilities. *Journal of Rehabilitation*. 66 (3), 44-50

Saborowski, M. & Kollak, I. (2015). "How do you care for technology?" - Care professionals' experiences with assistive technology in care of the elderly. *Technological Forecasting & Social Change*, 93, 133-140.

Shannon, C. E. (1948). A mathematical theory of communication. Reprinted with corrections from *The Bell System Technical Journal*, Vol. 27, pp. 379-423, 623-656, July, October 1948.

Scherer M. J. & Galvin J. C. (1998) Matching people with technology. *Rehab Management*; 9: 128-130.

Scherer, M. J. (2005). *Living in the state of stuck: How assistive technology impacts the lives of people with disabilities*. Brookline Books.

Scherer, M.J. & Glueckauf, R. (2005). Assessing the benefits of assistive technologies for activities and participation, *Rehabilitation Psychology* 50(2) 132-141.

Steel, E. J. & de Witte, L. P. (2011). Advances in European assistive technology service delivery and recommendations for further improvement. *Technology and Disability*, 23: 131-138.

Spinelli, G., Micocci, M. & Martin, W. (2018). Objects of desire and of disgust: analysis and design of assistive technologies. In: *Proceedings of the 5th Conference on Design4Health Sheffield, 4th-6th Sept 2018*

Spinelli, G., Micocci, M., Martin, W., & Wang, Y. H. (2019). From medical devices to everyday products: exploring cross-cultural perceptions of assistive technology. *Design for Health*, 3(2), 324-340.3:2, 324-340, DOI: 10.1080/24735132.2019.1680065

Spinelli, G., Micocci, M., Tseklevs, E., Wang, Y. H., Martin, W., Lim, Y., & Shamim, U. (2020). Contemporary themes in the design of at for the ageing population: materiality, co-design and cultural influences. *Design of Assistive Technology for Ageing Populations*, 41-58.

Shinohara, K. & Wobbrock, J. O. (2011). In the shadow of misperception: assistive technology use and social interactions. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 705-714).

Shinohara, K & Wobbrock, J. O. (2016). Self-conscious or self-confident? A diary study conceptualizing the social accessibility of assistive technology. *ACM Transactions on Accessible Computing (TACCESS)*, 8(2), 1-31. <http://dx.doi.org/10.1145/2827857>

Stumbo, N. J., Martin, J. . & Hedrick, B. N. (2009). "Assistive technology: Impact on education, employment, and independence of individuals with physical disabilities." *Journal of Vocational Rehabilitation*, 30(3), 99-110 DOI: 10.3233/JVR-2009-0456

Sugawara, A. T., Ramos, V. D., Alfieri, F. M., and Battistella, L. R. (2018). Abandonment of assistive products: assessing abandonment levels and factors that impact on it. *Disability and Rehabilitation: Assistive Technology*, 13(7), 716-723. <https://doi.org/10.1080/17483107.2018.1425748>

Steel, E. J. and de Witte, L. P. (2011). Advances in European assistive technology service delivery and recommendations for further improvement. *Technology and Disability*, 23:131-138.

Technology-Related Assistance for Individuals with Disabilities Act of 1988 (P.L. 100-407) [Internet]. [cited 2018 Mar 4].

From: <https://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg1044.pdf>

Verza, R., Carvalho, M. L., Battaglia, M. A., & Uccelli, M. M. (2006). An interdisciplinary approach to evaluating the need for assistive technology reduces equipment abandonment. *Multiple Sclerosis Journal*, 12(1), 88-93.

Wikström, L. (2002). *Produktens budskap: Metoder för värdering av produkters semantiska funktioner ur ett användarperspektiv* [Doctoral Dissertation]. Göteborg: Chalmers University of Technology.

de Witte, L., Steel, E., Gupta, S., Ramos, V.D., and Roentgen, U., (2018) Assistive technology provision: towards an international framework for assuring availability and accessibility of affordable high-quality assistive technology, *Disability and Rehabilitation: Assistive Technology*, 13:5, 467-472, DOI: 10.1080/17483107.2018.1470264

Wessels, R., Dijcks, B., Soede, M., Gelderblom, G. J., and De Witte, L. (2003). Non-use of provided assistive technology devices, a literature overview. *Technology and disability*, 15(4), 231-238.

Wielandt T., and Strong J. (2000). Compliance with Prescribed Adaptive Equipment: A Literature Review. *British Journal of Occupational Therapy*. 63.2. 65-75. doi:10.1177/030802260006300204

World Health Organization. (2001). *International classification of functioning, disability and health: ICF*. Geneva, Switzerland. World Health Organization. <https://apps.who.int/iris/handle/10665/42407>

World Health Organization. (2023). Assistive technology. Key facts. Retrieved from: <https://www.who.int/news-room/fact-sheets/detail/assistive-technology>

World Health Organization. (2020). Disability and health, Key facts. Retrieved from: <https://www.who.int/news-room/fact-sheets/detail/disability-and-health>

World Health Organization. (2023). Disability and health, Key facts. Retrieved from: <https://www.who.int/news-room/fact-sheets/detail/disability-and-health>

Zimmerman, J., Forlizzi, J. & Evenson, S. (2007). Research through design as a method for interaction design research in HCI. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 493-502).