

Practical experiences with different ways of eliciting information on ‘soft’ user requirements for assistive technology

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Abstract

Users do not always adopt assistive technology (AT), but abandon it since it fails to meet their needs. Some users experience stigmatisation. Historically, AT design has focused on functionality, performance and safety. However, for AT users, other less tangible, 'softer' areas are also important, such as emotional or social needs. The focus on the more tangible aspects of AT is probably one explanation why it often does not meet users' needs or fit into users' everyday lives. Therefore, AT designers must also understand users' 'soft' requirements. In this project, aimed to design a user-friendly AT device for short-distance individual transfers indoors, 36 user interviews were carried out. In the interviews, pictures of AT devices were used to visualise the AT concept under development. Fifteen of the interviews included questionnaires with semantic differential scales. The practical lessons learned point to the importance of actively triggering the users to reflect on issues beyond functionality and safety, and that the use of pictures and semantic scales had an effect on the character of the data elicited. The implications are that users need support in envisaging both the product being designed and its context in order to express requirements for soft qualities.

Introduction

Over a billion people, or about 15% of the world's population, have some form of disability and the number is increasing, partly as a result of an ageing population and the increase in chronic health conditions (The World Bank, 2018). Many individuals with disability and impairment use assistive technology (AT) in their everyday lives, and the need for and use of AT are increasing (Smith et al., 2018). One category of AT comprises aids for transport (e.g. wheelchairs) and aids which facilitate transferring a person from one place to another, for example from bed to wheelchair (e.g. sling lifts). However, there are studies arguing that users abandon certain AT solutions as they do not fulfil users' needs (Riemer-Reiss & Wacker, 2000; Alper & Raharinirina, 2006) and because users experience stigmatisation when using them (e.g., Louise-Bender Paper et al., 2002; Parette & Scherer, 2004).

One reason may be that the dominant perspectives in AT design are still functionality and performance whereas research has shown that users' needs and

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requirements for products do not only concern functional, or instrumental, aspects. Other, 'softer' needs and requirements must also be considered in the development process (Mallin & de Carvalho, 2015), including aesthetic qualities (e.g. visual, haptic, etc.) (cf., e.g., Desmet & Hekkert, 2007), hedonic aspects (e.g., pleasure, satisfaction and stimulus) (cf., e.g., Lai, 1997), and social consequences of AT use (see also Jordan, 2002; Norman, 2005). The implications are that designers need to develop better insight into these aspects to fulfil users' needs and requirements and to overcome problems of AT abandonment and user stigmatisation. However, whereas user requirements for functionality etcetera may be relatively easy to identify and formulate (as they refer to more visible and conscious requirements), the 'soft' requirements require another type of elicitation methodology (cf. Karlsson, 1996; Visser et al. 2005). However, knowledge is limited on how to elicit more in-depth information from users on soft values overall, and in particular when it comes to AT.

Aim

The overall aim of the work is to contribute to the understanding of how to elicit information on 'soft' requirements, in this particular case for AT. By 'soft' requirements we mean requirements concerning product aesthetics, product meaning, and hedonic aspects with consequences in terms of appeal, satisfaction, self-esteem, and identity. The main research questions are 'How does the design of a user study affect the elicitation of 'soft' user requirements?' and in particular 'How does the choice of data collection method and participants influence the type and character of the information elicited?'

The focus of this paper is the contents and outcome of two user studies in which semi-structured interviews and semantic differential scales (SDQs) were used to collect information from different user categories in order to elicit information on 'soft' requirements for an AT.

Research setting

A design project was carried out with the purpose to design a contemporary AT device to facilitate short-distance individual transfers, independently and/or with support of one person. The goal was a conceptual solution allowing for enhanced independence, accessibility, and mobility, and with an aesthetically appealing design that safeguarded users' dignity and integrity during transfer.

The design of the first concept, model A, was based on a benchmark product analysis and available knowledge in the project team (industrial design, human factors, orthopaedics, medical technology, electronic engineering and manufacturing). Keywords guiding the ideation were "light", "clean", "contemporary" and "un-engineered" in contrast to the more technological appearance which characterises traditional aids. To create these product expressions (cf. Monö, 1997), the technology was hidden and the shape of the device was chosen to mimic an "organic living thing" as opposed to sharp, square, hard surfaces resembling something machine- or man-made. Additionally, innovative functions were added to enable independency including motorised power wheels, a

kneeing/stretching function to adjust seat height and provide different seat positions (incl. sitting astride), handlebars for steering and braking and the possibility to disassemble the device for transport. A user study was completed to elicit user responses, and based on the input, the initial design was modified, resulting in a new model, model B, which was evaluated in a second user study. The user studies constitute the empirical basis for this paper.

The user studies: overview

The two user studies, user study 1 and user study 2, were completed in partly similar, partly different ways (Table 1).

Table 1. Overview of the user studies

	<i>Method</i>	<i>Participant / User group</i>	<i>Product representation</i>
Study 1	Interviews	A, B, C, D	2D and 3D visual representation of AT model A
Study 2	Interviews and Semantic Differential Scale Questionnaire	A, C, D A, C, D	2D and 3D visual representation of AT model B; Photos of different use environments

The recruited participants represented four different user groups in terms of their respective role in relation to and use of the AT:

- A. primary users, individuals with physical impairments (all wheelchair users),
- B. relatives as caregivers,
- C. professional home health caregivers, and
- D. orthopaedics ward hospital staff.

User study 1 followed a general procedure to search for users' needs and requirements and to evaluate the design of model A. Hence, the interviews included a brief introduction of the conceptual AT before open-ended questions were asked on topics such as accessibility and usability e.g., of power wheels, kneeling/stretching function, and different seat positions, if/how the device would enable independency, as well as the design appearance and size of the AT with the support of visual representations. A large part of the interview revolved around five typical indoor transfer situation situations: from and to i) bed, ii) wheelchair, iii) chair, iv) shower and v) toilet.

User study 2 followed a similar procedure albeit with a clearer focus on evaluating the modified concept, i.e. model B. In addition to interviews, the study included a semantic differential scale questionnaire (SDQ), which had been developed based on the interview data collected in user study 1. The purpose of including the SDQ in the second user study was to prompt all participants to reflect on and identify some of the softer values of the visualisations of the concept. The participants in study 2 were a mix of informants from study 1 and new informants, which is why the

decision was made to hand out the questionnaire after the interview. The idea was that the face-to-face interviews would help build trust between the interviewer and the interviewees, and that the participants would be able to discuss the topics before answering the more structured questionnaire. Thus, this procedure was expected to result in more informed answers.

All interviews were carried out by a researcher (first author, who was also the industrial designer creating the design concept) and took place at a location according to the preference of the respective participant. As a consequence, the environments varied between private homes, cafeterias, offices, home care units and hospital wards. The interviews lasted between 30-45 minutes. In addition to written notes, the interviews were audio-recorded and the recordings later transcribed verbatim for further analysis. The transcripts were coded into categories and themes in a process inspired by Miles' and Huberman's (1994) three-stage approach of data reduction, initial coding, and search for themes.

All of the participants participated voluntarily with consent and the data gathered is protected by PUL and GDPR laws.

User study 1

Method and materials

Study 1 involved face-to-face interviews with 21 participants, representing the different user groups A, B, C and D. Almost all were experienced transfer device users.

Table 2. User study 1 involved altogether 21 participants, between 30 to 83 years of age

<i>Category</i>	<i>Men</i>	<i>Women</i>
Primary users with physical disabilities	3 men	4 women
Relatives as care giver	2 men	1 women
Home care giver	2 men	6 women
Hospital nursing staff	2 men	women
Occupational therapist		1 woman

The interviews were supported by visualisations of the concept, model A (see Figure 2). After the introduction, the participants were asked for feedback, to describe possible problems on the concept and to reflect on and describe if and how they were likely to use the AT device as well as their thoughts on different aspects of the design, including functionality, safety, interaction, appearance, etc.



Figure 2. Visualisations of model A (shown on a small tablet screen placed in front of the participant)

Findings

The interviews provided information on ergonomical aspects, perceived usability, and technical features as well as on perceived problems associated with safety, functionality and efficiency. For instance, the motorised wheel function to operate the device was experienced as something positive from an independence perspective (as less physical strength was needed to accomplish transfers), but also as something negative from a safety perspective. Modifications of the design and solutions perceived were also suggested, e.g. an additional tilt restraint function, requested primarily by the caregivers (group C) to prevent the device from overturning.

‘Soft’ requirements, often related to aesthetics, were expressed primarily by the primary users (i.e. group A) who wanted the device to “melt into” their homes, to “look good” and “cool” as “... most aids are so ugly...” (female user, group A) and because “... that aids should look cool and all that have always had such a low priority” (male user, group A). User groups B, C, and D primarily responded to the safety, functionality and efficiency of the device, for example transfers to and from the device and between the different areas. The user categories also differed in response to some specific design solutions. Some primary users perceived the proposed astride position (i.e. sitting with legs on each side of the seat, see Figure 3) as positive, in that they could have eye contact with potential assistants but the dominant experience was a feeling of being physically and emotional exposed especially in situations associated with personal hygiene. User groups C and D responded to this same option mainly in terms of efficiency and functionality.



Figure 3. The astride sitting position.

Reflections

The user study was constructive and effective from a design practice perspective as a way to evaluate and get feedback on an initial design concept at a low cost. Based on the user evaluation, the design concept was modified to fit the users' needs and requirements better (e.g. the construction was changed to prevent the astride exposure experience, a remote control to enhance independence and a tilt restraint function were added to prevent the device from overturning and the user sitting on the device from falling backwards).

The semi-structured interviews were supported by product representations (PRs) which were considered beneficial in the exploration of functionality and usability aspects across all user groups. They also helped focus the questions around the AT and context of use and triggered the participants to respond to the concept, with requirements and/or solutions of assumed future problems, as well as thoughts on the visual appearance of the AT. The PRs were also considered to elicit information regarding intimate situations without the participants being exposed to the physical situation, as opposed to using a physical prototype to try out functions.

Nevertheless, the user study was not considered to be fully satisfactory regarding the in-depth exploration of the soft aspects of the AT. The majority of informants did not mention these aspects at all if not specifically asked, which indicates either that the aspects were not considered important and/or that the participants had difficulties in communicating their needs and wishes. A decision was therefore made to modify the second user study and introduce a semantic differential scale as a tool to support the participant in their evaluation of the modified model B.

User study 2

Method and material

User study 2 involved interviews with 15 participants (of whom some were the same individuals as in user study 1, i.e. all of the primary users) representing user groups A, C and D (Table 3). The interviews generally followed the structure of the interviews in study 1 but were supported by visualisations of the refined concept, model B (see Figure 4).

Table 3. Study 2 involved altogether 15 intended users as participants, ranging from 30 to 65 years of age

<i>Category</i>	<i>Men</i>	<i>Women</i>
Primary users with physical disabilities	2 men	3 women
Home care giver	2 men	4 women
Hospital nursing staff	2 men	1 woman
Occupational therapist		1 woman

Directly after the interview, all participants filled in the semantic differential scale questionnaire (SDQ) based on their impression of model B. Many of the participants commented on and explained their answers. As suggested by Wikström (2002), bipolar adjectives were chosen specifically for the product category and the target group. Hence, adjectives frequently mentioned in user study 1 were extracted and clustered according to similarity. In this way important themes could be identified. The questionnaire was organised into five different themes: themes 1-3 addressed to what degree the product communicated aesthetic, emotional and functional values (e.g. elegant – clumsy, dependent – independent), theme 4 how the participants estimated that the device would make them feel (e.g. dignified – undignified) and theme 5 how the participants perceived the AT to “fit” into three different use environments (e.g. fit in completely – not at all). These were visualised with photographs showing bathrooms with toilet and shower illustrating a private home, and a healthcare and hospital environment respectively.

Findings

As anticipated, the character of the information elicited from the interviews had large similarities with user study 1. The majority of comments focused on functionality, efficiency and safety aspects but there were some differences. For example, the primary users elaborated their requirements further to also include other use areas than the five situations presented in the interview, for instance transport, and additional requirements were posed: “...// to have something like a transport box to put it in”... (male user, group A). One explanation for their ability to describe their requirements in more detail could be the participants’ involvement in study 1 which had brought the design of ATs ‘to the surface’.

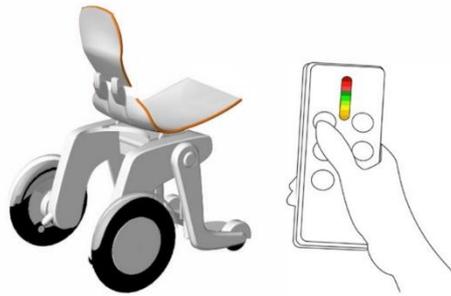


Figure 4. Visualisation of modified model B, with hand control

In addition, comments implied that functions were not only assessed based on functional values, but also on identity. One example concerned the tilt restraint function: "This is a chicken variant, I don't operate like that" (male user, group A). Another comment concerned feelings assigned to the device's appearance in a home context: "It does not have to scream 'aid', but if it has a "tougher" design it becomes so much easier to live with it." (male user, group A).

Overall, the responses to the questionnaire were very similar across the different user categories (Figure 5); a majority rated model B as expressing values such as "modern", "dignified" and "practical". Motives for the ratings were also verbalised: "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).

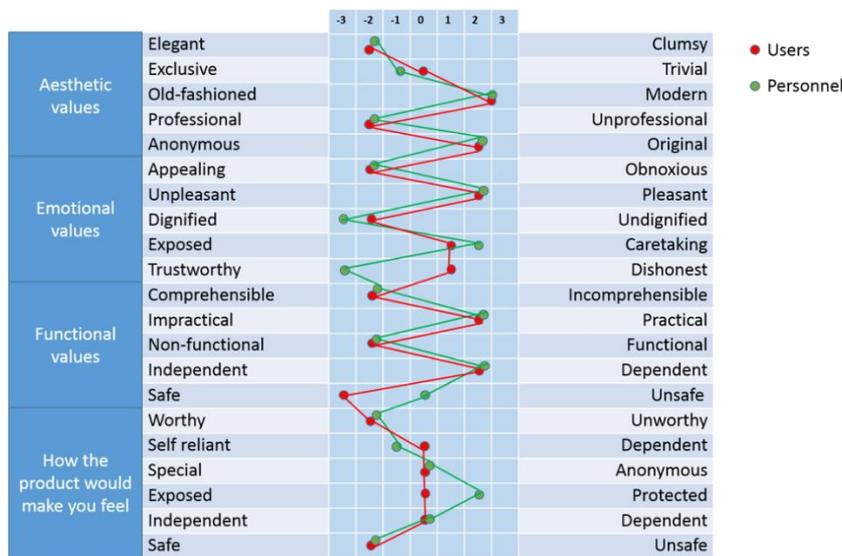


Figure 5. How the primary users and the personnel answered the SDQ

Differences between groups mainly concerned the responses on how the AT would make them feel. Some users felt that it was just another accessibility aid: *"And it's just, like, kind of another aid"*. (male user group C). Others felt equipped and independent: *"If a thing like that turns up then I can cope on my own"* (female user group C). One participant explained that answering the interview and the SDQ had affected him emotionally: *"I was touched somehow...//... The emotional aspects, they are an important thing."* He also described many patients' emotionally reactions of using transfer aids in the hospital: *"Some patients think it's terrible having to sit in a wheelchair after an operation ...//...some understand that this is more or less temporary, because I will be able to walk again... // ...It's a little like that, being able to find acceptance in having to sit in one, in a wheelchair"* (male user, group D).

There were also some differences in how the participants perceived the AT to fit the different use environments shown in the photos. Some participants did not think the environment mattered: *"If I think that if it (the AT) fits or not in all of these (environments) doesn't matter"* (female user, group D). Other participants, in particular from group A, began to reflect on how the design would fit their own home: *"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"* (male user, group A).

However, despite the interviews and SDQs, there were participants who found it difficult to express their thoughts: *"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).

Reflections

The 2D and 3D representations in combination with the SDQ helped participants to focus on the design concept - it became evident to the participants that it was the specific concept that was the object of the evaluation and not AT in general.

Overall, the questionnaire had a considerable impact on the character of the data elicited. In comparison with the data from the interviews, the SDQ was considered more effective in gathering information on the soft factors (i.e. product expression or meaning and the resulting emotions) and from all categories of participants (in the interviews, many of the soft aspects were addressed only by the primary users). The SDQ not only provided ratings, but also triggered many of the participants to verbalise and elaborate their thoughts on the soft aspects implying that such an instrument could be used as a trigger also in a user requirement elicitation study (cf. User study 1). Nevertheless, while the SDQ data in the specific case did not result in specific design requirements, important insights and reflections were enticed by the SDQ concerning the affective connotations and emotional dimensions of an AT product. This information is vital for design practitioners to understand and relate to when making design choices, in order to e.g. develop an AT that does not contribute to user abandonment and stigmatization.

Discussion and conclusions

Methodological considerations in efficient requirements elicitation include e.g. the choice of *data collection method*, *participants* and *mediating tools* (stimuli) in order to enhance the data collection process (see e.g. Karlsson, 1996; Engelbrektsson et al., 2000). The importance of the choice of participants was evident in that the participants' different roles in relation to the device (i.e., as primary users versus caregiver) and use situations (home versus workplace) affected their thoughts on soft product values per se. Primary users saw a value in this issue and expressed several needs and wishes while caregivers did not experience the same needs. Hence, the character of the information elicited varied from practical and work-oriented aspects to personal and emotional values.

The 2D and 3D images had two functions: first as product representations, i.e. representations of the new design, and second as mediating tools in eliciting information. The two AT solutions represented by 2D and 3D images supported the participants in envisaging a new AT under development regarding functionality, use purpose and context, making them suggest changes and solutions and also to express some requirements regarding soft product aspects to increase user acceptance. Earlier studies have demonstrated the impact of product representation and the type of information carried on the information elicited in user studies (Söderman, 2001). A full-scale prototype or mock-up may have resulted in additional feedback regarding e.g. the size and functionality of the aid whereas the elicitation of soft requirements might have gained more by introducing images of different design appearances, enabling comparisons of visual impressions.

If the 2D and 3D images made the participants focus on the object, the interior photos showing the different environments made them reflect on the AT in a broader perspective and context than the participants' main use environment (e.g. hospital, home) and their role in relation to ATs (i.e., as primary user, caregiver or hospital staff). Additional photos showing other use contexts would probably have had a big impact on the information elicited as different situations play an important role in how individuals perceive usage and value a product and hence on the information elicited (cf. Correia de Barros et al. 2011).

Semantic differential scales (Osgood et al. 1957) are most often used to measure the connotative meaning of and emotional attitudes towards e.g. a product. Also in this study, the SDQ was used to acquire participants' rating of product expressions (or meaning) as well as ratings of how the design made them feel. However, this appeared to support their awareness of the design beyond the merely practical functions, hence the SDQ also had a mediating role. For some this mediating role extended to helping them describe their thoughts on the themes included in the questionnaire in more detail as well as developing previous experience and memories. Mediation is thus essential to elicit users' softer requirements for AT, its aesthetic and symbolic functions (cf. Mallin & de Carvalho, 2015) and the meaning assigned to AT which plays an important role in understanding the mechanism behind acceptance and rejection.

In conclusion, user studies provided information as a useful basis for design decisions regarding the new AT. However, several decisions had an impact on the character of the information elicited including the choice of participants, data collection methods, and product representations. Different user categories may, as in the case of AT, pose and/or emphasise different types of requirements for the product and these differences must be considered in the design of the user study. Furthermore, different requirements are accessible to different degrees and mediating tools are an important key in the elicitation process, especially information on 'soft' aspects which is more difficult to elicit than information on more instrumental product aspects. In the case of AT design, the role of product representations and mediating tools, including product representations, photos and semantics scales, is especially important as these can help the user to envisage a product and context of use, predict possible use problems, and help reveal design aspects which are essential for AT to be successfully integrated into individuals' everyday lives and improve well-being.

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